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REPORT

—ON THE—

SEWERAGE AND DRAINAGE

OF HOBOKEN, NEW JERSEY

—BY—

JAMES H. FUERTES

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New York, Sept. 15th, 1912.

The Hon. The Mayor and City Council, Hoboken, N. J.:

Gentlemen—Pursuant to your request expressed in a resolution dated January 1st, 1912, I have made an investigation of the sewerage and drainage of Hoboken, and submit herewith my report thereon.

The plans of many of the existing sewers in Hoboken have been available for my inspection but have yielded little of value with regard to their present conditions for the reason that in many places they have settled down from three to four feet below their original positions. None of the plans affords information as to how these various sewers connect at intersecting points, or as to through which outfalls the sewage from the different districts is discharged; nor was recent information available as to the extent or character of the deposits in the sewers, or as to the velocities of flow therein at different stages of the tides. No data could be had from existing records as to the actual present elevations of streets as compared with former elevations, nor as to ground water elevations. My investigations have been extended to secure all the necessary data as to these matters, as well as to ascertaining the locations where discomfort and injury have resulted from street floodings; as to the extent of area inundated during heavy rain storms; the reasons for the failure of certain sewers to give relief to the districts they drain; the causes of local nuisances at different places; the nature of the soil where works will have to be built; the suitability of points for the discharge of sewage; the advisability of reducing the areas tributary to some of the existing sewers; the effect of the method of operating the tide gates on the flow in the sewers; the relative merits of using, or dispensing with, tide gates, and other matters which it is unnecessary to enumerate. Many of these subjects have taken up much time as the observations could be made only at certain stages of the tides, and although I regret the delay in completing the work, it has seemed impossible to hasten it excepting at the expense of thoroughness.

It would have been far easier to have designed a new system throughout, but in view of the great expense represented by the existing sewers it was necessary to study these carefully to ascertain what portions could be properly used in the new system and what portions would have to be rebuilt or abandoned.

From the data collected I have been able to devise a plan of sewerage and drainage, not involving pumping, which will satisfactorily meet the conditions. This plan, which is hereby recommended for adoption, is referred to in the following report and accompanying drawings, as Plan B. Its essential features are:

1.—A system of combined sewers to receive both the sewage and storm water of the unsewered part of the city.

2.—The rebuilding of several of the existing sewers.

3.—The reduction of the area tributary to certain of the existing sewers by diverting some of the sewage therefrom to the new sewers.

4.—The extension of the outfalls, for the dry weather flow of sewage, to the pierhead line.

5.—The provision of arrangements for properly flushing the sewers.

6.—The establishment of grit chambers and automatically cleaned screens at the outfalls.

7.—The diversion of the sewage from the canal and from slips and docks along the river front.

The cost of establishing the new system, complete, would be about $676,840.00, and the annual cost of maintenance and operation about $4,300.00, exclusive of interest and sinking fund charges, or about $38,150.00 per year including these items at 4½ per cent. and ½ per cent., respectively. The building of certain portions of the work, however, can be deferred until necessary, and the first cost be reduced thereby correspondingly.

The data upon which these recommendations are based will be found in the following report.

Respectfully submitted,

JAMES H. FUERTES,

Consulting Engineer.

REPORT ON THE SEWERAGE AND DRAINAGE OF HOBOKEN, N. J.

PART I.

Description of the Present Sewerage and Drainage Works of Hoboken.—General Conditions.

Topographical.—The City of Hoboken, N. J., lies on the west bank of the Hudson River, north of and adjoining Jersey City, and is approximately rectangular in shape, with a water frontage along the river of a little over 1¾ miles and an extreme width, from the pierhead line to the west boundary, of a little over a mile. The total area within the corporate limits is about 837 acres, and the population was 70,324 in 1910, according to the U. S. Census.

The surface of the city is generally quite flat, sloping back gradually to an elevation of only a foot or two above high tide. The only break in this relatively uniform surface is the small hill known as Castle Point, located about half way between the north and south lines of the city on the river front.

Street Grades.—Originally the western portion of the city was a marsh; its limits are shown on Sheet No. 1. Portions of this marsh have been filled up and built upon, practically all of the buildings and important structures within that area being upon pile foundations. Grades have been officially established on all of the streets within the city limits.

Built-up Areas.—About 75 per cent. of the available area of the city is now built upon. The land which is now vacant lies practically all in the lowest part of the city and for this part no adequate drainage has as yet been provided. The low area, where trouble is at present experienced with flooding of streets during rain storms lies, as a rule, to the west of the line of Garden street, from Ferry to Third street, and west of Willow avenue, from Third to Tenth street, and west of Adams street, from Tenth to Thirteenth streets, and west of Hudson Boulevard East, from Thirteenth street to the north line of the city.

Areas Subject to Flooding.—Sheet No. 1 shows the areas that were covered with water on March 30th, 1912. A reference thereto will show that a large proportion of the unoccupied area of the city is at present without a proper drainage system. The water areas shown on the map remain more or less in this condition throughout the year; during the summer time the pools are not quite so deep, but the water becomes stagnant resulting in obnoxious odors and unsanitary conditions.

The areas upon which the water stands during dry seasons lie from 1 to 3 feet below the street levels and at about the elevation of high tide in the harbor.

The streets in the low-level parts of the city and the areas enclosed by them have been raised to their present elevations with ashes, loam and city refuse. Excavations from 3 to 5 feet deep in such streets in various parts of the city disclose a loose, porous material, the sub-soil being a soft muck, or silt, of great depth.

All structures of importance, even one and two-story buildings, have to be put on pile foundations to prevent settlement. The lengths of the piles vary in different portions of the city, but range from 25 feet to 110 feet in length. Data regarding the lengths of the piles used in the foundations of various buildings will be found in Appendix A.

Methods of Sewerage Employed.—A large part of Hoboken is provided with sewers. The system is quite complex and, in many places, in bad repair. The greater part of the sewage empties into the Hudson River through outfalls on Fifteenth street, Fourteenth street, Eleventh street, Third street and Ferry street, and a large amount is also dischargd into the canal, just south of the Hoboken corporation line. A number of small independent outfalls discharge into the Hudson River from small areas, and other outfalls formerly emptied sewage into the canal at several points.

Practically all the existing sewers are on the combined plan; that is, they receive not only the surface water from the streets, but also the sewage from the buildings and manufactories. Much difficulty has been experienced with the sewerage of Hoboken because the low elevation of a large part of the city makes it impossible to provide sewers the outfalls of which can discharge at, or above high tide level. All the sewers, consequently, are tide-locked and, owing to the absence of flushing provisions, form long deposit chambers in which sewage solids settle upon the bottom when the flow is checked by the rising of the tide. The putrefaction of the deposits on the bottoms of these sewers causes, during hot weather, offensive conditions in several localities.

Tide Gates.—In order to improve conditions in this regard tide gates have been placed at four of the outfalls, namely: At Ferry street and Park avenue, Ferry street and Hudson street (where there are two gates) and Third and River streets. A tide gate is located at the former outfall near Henderson street, but is not now in use, having been abandoned some years ago. The sewage that formerly discharged through this outlet is now discharged either through the outfall at Ferry street and Park avenue, or Ferry and Hudson streets.

The gates at Park avenue and Ferry street, and Hudson and

Ferry streets are operated by standards located in small shanties directly over the gates. The gate at Third and River streets is automatic in its action and does not require attention except for occasional oiling and clearing of refuse.

In the floor of each gate house there is a manhole through which the gate tenders can observe, if they care to, whether the current in the sewer has reached a velocity, which, in their judgment, would show that the tide is rising or has reached such an elevation that it produces very little current at the outfall. The automatic gate at Third and River streets is similar to an ordinary flap valve. It consists of an iron disc probably about 5 feet in diameter, hinged slightly above the top of the sewer, and is moved outward as the tide recedes, and back against the walls of the sewer as the tide rises.

The other gates are operated by hand by two gate tenders, one for the day shift and one for the night. Each follows a slightly different system as to the time of opening and closing. One tender opens the gates one hour after high tide and closes them one hour after low tide, but varying this in accordance with whether the tide is unusually low or unusually high.

The other tender opens the gates from three and one-half to four hours after high tide and closes them from two to two and one-half hours after low tide.

From actual observation one day this latter gate tender was preparing to close the Ferry street outfall at Park avenue one and one-quarter hours after low tide, at which time there was a very strong flow outward. By waiting it was found that it was two hours after low tide before the outward flow stopped.

From many observations made in different parts of the city, and at various times, it is found that in the trunk sewers there is a strong outward flow during a period of four hours, two hours before and two hours after low tide. Under ordinary circumstances the proper time to open the gates would be directly after high tide, and for closing them, two hours after low tide.

During rain storms, however, unless the gate tenders happen to be on hand, the failure to open the hand-operated gates may cause the sewers to fill up and overflow and flood the streets in the lower parts of the town.

Street Settlement.—No data are available regarding the grades of the streets as actually constructed, but a large portion of the paved streets in the lowland district are found at a much lower elevation than the official established grades. Table No. 1 has been prepared to show some of the differences actually found; it will be obesrved that a great number of the intersections are from 10 inches to 26 inches lower than the estimated grades.

TABLE I.

Streets.	Established Grade. (Feet.)	Grade April, 1912.	Present Grade below established Grade.
Ferry and Garden.....	4.8	4.5	3½ inches
Ferry and Willow.....	3.0	2.42	7 "
Ferry and Jefferson....	3.0	2.70	3½ "
Ferry and Madison....	3.0	2.74	3 "
Ferry and Monroe.....	3.0	2.56	5 "
Ferry and Jackson.....	3.0	2.50	6 "
Newark and Garden...	2.5	1.68	10 "
Newark and Park.....		1.8	
Newark and Willow....		1.7	"
Newark and Clinton....	3.0	1.06	11 "
Newark and Grand....	3.0	1.22	21½ "
Newark and Adams....	3.0	1.53	18 "
Newark and Madison...	3.0	2.62	4½ "
Newark and Monroe....	3.0	2.47	6½ "
Newark and Jackson...		2.6	
First and Garden.....	5.0	4.75	3 "
First and Park.....	3.0	2.64	4 "
First and Willow.....	3.0	2.59	5 "
First and Clinton.....	3.0	2.22	9½ "
First and Grand.....	3.0	2.62	4½ "
First and Adams.....	3.0	2.51	6 "
First and Jefferson.....	3.0	2.72	3½ "
First and Madison.....	3.0	2.74	3 "
First and Monroe.....	3.0	2.34	8 "
First and Jackson.....	3.0	2.64	4 "
First and Harrison.....	3.0	1.60	17 "
First and Marshall.....	3.0	1.90	13 "
Second and Garden....	5.5	5.23	3 "
Second and Park.....	3.5	3.30	2 "
Second and Willow....	3.5	2.57	11 "
Second and Clinton....	3.0	1.58	17 "
Second and Grand.....	3.0	2.09	11 "
Second and Adams....	3.0	1.40	19 "
Second and Jefferson...	3.0	2.79	2½ "
Second and Madison...	3.0	2.80	2½ "
Second and Monroe....	4.0	3.64	4 "
Second and Jackson....	4.0	2.46	18½ "
Third and Garden.....	6.5	6.22	3½ "
Third and Park.....	5.5	5.40	1 "
Third and Willow.....	3.0	2.60	5 "
Third and Clinton.....	3.0	1.97	12½ "
Third and Grand.....	3.0	2.11	11 "
Third and Adams.....	3.0	2.47	6½ "

Streets.	Established Grade. (Feet)	Grade April, 1912.	Present Grade below established Grade.
Third and Jefferson....	3.0	2.74	3 inches
Third and Madison.....	3.0	2.74	3 "
Third and Monroe.....	4.0	3.45	6½ "
Third and Jackson.....	4.0	1.75	27 "
Fourth and Clinton.....	3.0	2.55	5½ "
Fourth and Jefferson...	3.5	2.70	9½ "
Fourth and Madison....	3.5	1.3	26½ "
Fourth and Monroe....	4.0	2.2	21½ "
Fourth and Jackson....	4.0	2.43	9 "
Fifth and Clinton.....	4.0	2.82	14 "
Fifth and Monroe.....	4.0	2.35	20 "
Sixth and Clinton.....	4.0	3.26	9 "
Sixth and Jefferson.....	4.0	3.30	8 "
Sixth and Monroe.....	4.0	3.05	23 "
Seventh and Clinton....	4.0	3.18	10 "
Seventh and Monroe...	4.0	2.91	13 "
Eighth and Grand.....	4.5	4.31	2 "
Eighth and Adams.....	4.5	4.38	1½ "
Eighth and Jefferson...	4.5	4.17	4 "
Eighth and Monroe....	4.5	3.56	11 "
Ninth and Clinton.....	4.5	4.30	2 "
Ninth and Adams.....	4.5	4.30	2 "

No. 1. View taken to show street settlement. This is on Adams Street, between Eighth and Ninth Streets, looking north. The ridge in the centre of the street denotes the location of the sewer (which is on piles), and the original surface of the street . The street seems to have settled about a foot on the left side only.

No. 2. A view taken from a point south of the United States Rattan Company's factory in order to show the settlement of Madison street, near Eleventh street. The cross denotes the low point with water over it and on either side. Note the water hydrant on other side of the street on portion that evidently has not settled.

Indications that the streets in the lowlands have settled considerably, even if not constructed at the established grades originally, can be observed in different parts of the city. Specific evidence of this fact is shown on many streets by the ridges in their centers, over sewers, the plans of which show them to have been designed with pile foundations. That the sewers were actually built on piles is stated by many residents who saw them constructed. Since the profiles show the sewers to have settled somewhat, the ridges indicate that the streets have settled even more than the sewers. Photograph No. 1 shows one of the ridges as well as the settlemnt of the west side of Adams street, between Eighth and Ninth strets. Settlement of the sidewalks and curbs are plainly visible in different parts of the city. Photograph No. 2, for instance, shows the settlement of Madison street, near Eleventh street.

Messrs. J. & W. Stanley state that Grand street, between Thirteenth and Fourteenth streets, has been settling continuously for about twenty years, and that their company has been compelled to keep refilling it during the entire period.

Settlement of Sewers.—Owing to the boggy nature of the ground, the sewers, excepting those on a firm pile foundation, have settled out of line and grade so that, in some cases, their slopes are now in directions the opposite of those originally laid out. In such cases the sewage cannot escape from the sewer until it is filled completely. In some instances sewage stands above the top of the sewer in the manholes, and in a few cases appears even in the catch basins at street corners. Most of the sewers that have been placed upon piles are in fairly good condition as to line and grade, although very few can be called first class.

Types of Sewers.—About 89 per cent. of the sewers are of brick masonry and are circular, oval or egg-shaped in section; about 10 per cent. are wooden boxes, and about 11 per cent. are pipe sewers. The box sewers are rectangular and generally about 3 feet by 4 feet in section. The pipe sewers are confined to the relatively high portion of the city, that is, to the portion lying between Willow avenue and the Hudson River.

Interconnecting Sewers.—All the sewers in the lowland district are so constructed and located that the sewage can flow from one main trunk sewer to another; that is, the sewage discharging through the Third street trunk could be made to discharge through the Ferry street trunk sewer, and vice versa. In fact, at certain stages of the tide this has been observed to occur.

Overflowing of Sewers.—The storm water resulting from rainfalls finds its way into the sewers through catch basins located at the street corners and connected with the sewers by sewer pipes. The city does not maintain an organization for systematically clean-

ing out the deposits which accumulate in these basins, the cleaning being done usually only after complaint has been made. Owing to the flat slopes of the sewers, and to their being tide-locked (which practically checks the velocity of flow in the sewer for several hours each day) deposits are bound to form both in the sewers and in the catch basins and, as a result, street flooding is bound to occur during heavy rain storms. In Appendix B will be found notes of interviews with property holders, as well as with the proprietors and managers of several manufactories, as to their experiences during floods, particularly during that of March, 1912. The conditions complained of are in some of these instances intolerable.

Ground Water Levels.—In portions of the city some distance away from the harbor the ground water level does not fluctuate much with the rise and fall of the tide. At Monroe and Sixth streets the ground water was found to be at elevation -0.8 one and a half hours after low tide. Probably a fluctuation of one foot, between elevation zero and -1.0 would be the maximum that would occur in this vicinity.

In those parts of the city close to the harbor, say in Wards Nos. 1 and 4, the fluctuation is much greater and more nearly coincides with the rise and fall of the tides, probably between zero and -3.0.

THE PRESENT SEWERAGE SYSTEM.

Drainage Areas.

There are in Hoboken eight different drainage areas, designated herein, for convenience, by the names of the streets at which they discharge their sewage, namely: Ferry street, Court street, Newark street, Third street, Hudson Square, Eleventh street, Fourteenth street and Fifteenth street.

Ferry Street System.—This is the largest of all the drainage areas, 205 acres being tributary to the main sewer in Ferry street. Except for a small area drained by the Bloomfield street sewer (which discharges into the Ferry street outfall at the corner of Bloomfield and Ferry streets) the area draining to the main Ferry street sewer is confined to the **lowland** district. Besides the Bloomfield street sewer, there are two main collectors for this system; one termed the Jefferson street collector, and the other the Park avenue collector. The Jefferson street collctor drains an area of **107 acres** and discharges into the Ferry street outfall system at the corner of Jefferson and Ferry streets. The Park avenue collector drains an area of **25 acres** and discharges into the Ferry street outfall system at the corner of Park avenue and Ferry street.

For the Ferry street system there are two separate outfalls, one at Park avenue, which discharges into the canal south of the D., L. and W. yards; the other at the corner of Ferry and Hudson streets, which discharges into the Hudson River at the pierhead line through two lines of 48-inch cast-iron pipe laid under the tracks and train-shed of the D., L. and W. Railroad, and beneath one of the long piers. The sewage can discharge through either one of the outfalls, but both are used simultaneously.

The Ferry street sewer and both its outfalls seem to be in good condition, and discharge very freely at or near low tide. This can also be said of the Jefferson street and Park avenue collectors.

Court Street System.—This drains a small area of **2 acres** between Ferry and Newark streets. It flows across the Ferry street sewer, but where it discharges cannot be determined. Possibly into the Ferry street outfall east of the tide gate.

Newark Street System.—The area discharging into the Newark street outfall is a small one, and is principally tributary to the Washington street sewer, which extends from Newark street to Sixth street. The area is limited to the highland district of the city, except for a very small area surrounding Hudson Place. The area drained is **30 acres.**

The outfall is located at the foot of Newark street, but exactly where cannot be determined. It originally discharged at the bulkhead at the head of a slip owned by the ferry company and used for overhauling the ferryboats and laying them up when not in use. There is no visible discharge into the slip and it is believed that the ferry company has bulkheaded the outlet, thus preventing a free discharge. At the manhole at the corner of River and Newark streets a fair current and flow can be observed, which shows that the sewage must find a free outlet.

Third Street System.—The area drained by the Third street sewer is almost entirely confined to that portion of the lowland district which is bounded on the south by Second street, on the west by Grand street, on the north by Twelfth street, and on the east by Garden street. A small area at the corner of Hudson and Third streets, located in the highland district of the city, is the only other area drained by this outfall. The total tributary area is **146 acres,** of which **140 acres** lie in the lowlands. The sewage is collected by a trunk sewer in Third street which reaches the outfall by means of a deep cut through the ridge between Garden and River streets, and discharges at the end of Pier No. 2, of the North German Lloyd Company. It passes under both the Bloomfield and Washington street sewers and has no connections therewith.

Hudson Square System.—The area drained by the sewers in the vicinity of Hudson Square discharge directly into the harbor at

the bulkhead line. They are all pipe sewers and drain **14 acres** of the highland district of the city.

Eleventh Street System.—The area drained by this sewer is located generally to the east of Bloomfield street and between Seventh and Twelfth streets. The total area drained, which is located in the highland district of the city, is **44 acres.**

Fourteenth Street System.—The area drained by the Fourteenth street sewer is located to the east of Hudson Boulevard and between Twelfth street and the Shore Railroad. The total drainage area is **35 acres,** and is all on the highlands.

Fifteenth Street System.—This is the only sewer draining the extreme northern portion of the city. It is a 2½ by 3 foot wooden box sewer, and extends from the bulkhead line near the foot of Fifteenth street, through Fifteenth street to Grand street, and thence to Thirteenth street. The portion in Grand street, between Fifteenth and Thirteenth streets, has been out of service for several years. Its drainage area is indeterminate.

TABLE NO. 2.

Summary of Drainage Areas of Hoboken Sewers.

	Area Drained.	
Drainage Systems.	Lowland District.	Highland District.
Ferry street (both at Park avenue and Hudson street)	181 acres	24 acres
Court street		2 "
Newark street		30 "
Third street	140 acres	6 "
Hudson Square		14 "
Eleventh street		44 "
Fourteenth street		35 "
Fifteenth street	Indeterminate	
Total (exclusive Fifteenth street)	321 acres	155 acres

CONDITION OF SEWERS AS TO FLOW, DEPOSITS AND SETTLEMENT.

The present sewerage system is in two zones, the Highland system and the Lowland system. Generally speaking, the former covers the drainage area east of a line midway between Garden and Bloomfield streets; the latter covers the district west of the same line.

The Highland System.—The sewers in this zone are well built and on good foundations; they have sufficient grades to give good velocities, and, except near their summits, have a fair amount of sewage constantly flowing in them. Even at the summits the sewers can be said to be in good condition.

The Lowland System.—Sixty-eight per cent. of the total area of the city sewered is located on the Lowlands.

Fifty per cent. of the total length of sewers included in this system is in fair or good condition; the other 50 per cent. being in bad or foul condition. Many of the sewers termed "fair" could be made "good" by an efficient flushing system, and a few termed "bad" could be made "fair" by the same means.

Where the sewers termed "fair" have been well built and have not settled, the trouble seems to be that they are too large and have too light gradients for the volume of sewage discharging into them. The result is that the sludge settles on the bottom and is never carried away. This is especially evident in the case of short sewers, and for two or three blocks at the summits of long sewers.

Profiles.—Profiles of several of the existing sewers located in the Lowland district are shown on Sheet No. 2. These profiles show the elevations of the street surfaces, elevations of the inverts and crowns of the sewers and of the surface of the flowing sewage at low tide, as well as the depth of the deposits of mud and sludge in the sewers in dry weather. The dark shaded areas within the sewers represent the amount and depth of mud and sludge. The portion cross-lined represents the amount of sewage constantly in the respective sewers; that is, the top surface, which represents the flow line at low tide, never gets any lower, this gradient being necessary to produce any flow whatever. Hence the larger portion of the cross-lined area (except in the long trunk sewers) denotes stagnant or very sluggish condition.

Jackson Street Sewer.—Sheet No. 2 shows profiles of some of the worst sewers. The Jackson street sewer is particularly bad, having settled along its entire length. From a point south of Second street to Fourth street, the settlement has been so great that the top of the sewer is below the flow line even at low tide; this causes the sewage to rise in the manholes and creates such foul conditions that residents in its neighborhood complain of its inefficiency and of the obnoxious odors it exhales, particularly in summer time.

The mud and sludge deposits in this sewer amount to about 65 per cent. of the sewer's volume. The part between Third and Fifth streets was built in 1896, and if the invert was constructed to the grade called for by the official plans (and it is unreasonable to think it was constructed at a lower elevation) the sewer shows an average settlement of 3½ feet between these points with a maximum of 4.8

feet. Similar settlement has occurred between First and Third streets.

Comparing this profile with the conditions revealed by Mr. McCann's inspection in 1900, the invert shows a settlement since that date of one to two feet between First and Fifth streets. It will be seen that at the present time the sewer ascends instead of descends toward the discharge end.

Monroe Street Sewer.—Monroe street sewer is in bad condition between Third and Seventh streets. Between Fifth and Seventh streets the surface of the sewage, even at low tide, stands higher than the crown, causing it to appear in the manholes all the time. Residents nearby complain of bad odors, especially during hot weather. The amount of mud and sludge in the sewer is equal to about 45 per cent. of its volume; for about one-third of its length, at the upper end, the deposits occupy fully 60 per cent. of its volume.

Comparing the elevation of the invert between Fourth and Fifth streets with the approved plans dated 1896, the sewer shows a settlement of from 1½ to 4.8 feet. Between Fifth and Eighth streets the invert has settled almost uniformly the whole length from 2½ to 3½ feet as compared with the undated plans on file. The sewer between these points must have been built since 1896.

Comparing the present invert with McCann's profile of 1900, it shows a settlement from 1½ to 3½ feet between Fourth and Eighth streets, and almost none between First and Fourth streets.

Comparing the elevations of the present invert, between Fourth and Fifth streets, with those shown on a filed map dated 1909, and made for the purpose of repairing the sewer by taking off the top of the old arch and building a new one at a higher elevation, a settlement of from 1 to 2 feet is found. The invert at every point is below the elevation of the discharge end of the sewer in amounts varying from nothing to 3½ feet.

These data indicate that the sewers are still settling.

Madison Street Sewer.—The Madison street sewer, while not quite so bad, is in a similar condition to the Monroe street sewer. The greatest settlement is at Fourth street, the invert having gone down 2¼ feet.

Jefferson Street Sewer.—The Jefferson street sewer, north of Third street, is in almost as bad a condition as the Monroe street sewer. The most serious settlement, about 3 feet, has occurred between Fifth and Seventh streets.

Adams Street Sewer.—In marked contrast with the above mentioned sewers, is the trunk sewer beginning at Ninth and Adams streets and extending along Adams to Third; thence to Jefferson; thence to Ferry, and thence to the outfalls at Park avenue and Hudson street. This sewer shows that even on the Lowlands of

Hoboken, with the necessarily light gradients and with the discharging period limited to about five hours at each tide, sewers can be maintained in good condition if they are properly built and have a sufficient flow of sewage. The invert of this sewer shows no perceptible settlement along its whole length; there is a good strong flow during about five hours of each tide, from summit to outfall, and the manholes are acceptably clean. The good condition of the sewer is ascribable to its having been put on a good foundation and to its copious flushing by the large quantity of water discharged into its head from the Hoboken Paper Mill.

It will be instructive to compare the Adams street portion of this sewer with that on Monroe street. The sewage of both meet at the same point (First and Jefferson streets) and continue to the same outfall. The distance from their intersection to the summit of the Adams street sewer is 3,950 feet and of the Monroe street sewer 3,725 feet. The summits of both were originally at the same elevation. Other things being equal, if no settlement had occurred the Monroe street sewer should, if anything, have a stronger current and be at least as clean as the Adams street sewer, because it is 225 feet shorter. But Monroe street is sluggish and unclean and has large stagnant spaces in which sludge can and does deposit.

Newark Street Sewer.—Comparisons of this same kind could be made with every sewer on the Lowland district. One of the most striking ones is that of the Newark street sewer. The sewage from this street and that from the Adams street portion of the trunk sewer above mentioned meet at Ferry and Jefferson streets and discharge through the same outfall. The distance to the summit of the Newark street sewer from the meeting point is only 1,150 feet; whereas the summit of the Adams street sewer is 4,650 feet distant. The Newark street sewer is a wooden box, probably 3 feet by 4 feet, and has settled about 3½ feet between Ferry and Jefferson streets and the city line. The box is practically filled with mud and sludge; its top is below the flow line, even at low tide and the sewage constantly stands so high in the manholes that no perceptible current can be observed. Its condition, of course, is most unsatisfactory.

Third Street Sewer.—The long trunk sewer discharging into the Third street outfall begins at Clinton and Twelfth streets; it follows thence along Clinton to Fifth, thence to Willow, thence to Third and thence to the outfall. The condition of this sewer may be termed good from the outfall to Sixth and Clinton streets. Just above this point the sewer changes from a 36-inch circular to a **20-inch** circular section, and at Eighth street this is again changed to a **24-inch** circular. A settlement has occurred between Sixth and Ninth streets which brings the crown of the 20-inch sewer between Willow Court and Eighth street below the flow line at low

tide. At Seventh street this is about 16 inches. Above Ninth street the sewer is on a grade of 0.13 per 100, but there is such a small amount of sewage discharged into it from the last block that the flow is sluggish, thus permitting accumulations of sludge. From Sixth to Twelfth street the quantity of mud and sludge in the sewer amounts to about 45 per cent. of its total volume.

The Third street portion of this sewer, although it has been termed in good condition, does not discharge as freely as it should on account of its invert being for a distance of about 1,500 feet below the elevation of the invert at the tide gate and also probably because the automatic tide gate requires an appreciable amount of head to open it.

Miscellaneous Short Sewers.—Also in bad order are a number of the shorter sewers. Even where they have not settled they show very slow velocities during their discharge, and are much clogged with mud and sludge. In many cases the inverts are at or below mean low water at distances ranging from 4,000 to 5,000 feet from the outfall. Since the flow line requires a gradient of about 0.3 per 1,000 even with a good flow of sewage, it is evident that the inverts are too low near their summits and for long distances therefrom. The consequence is that conditions are favorable for depositing mud and sludge in their bottoms. This could undoubtedly be partly prevented in a number of cases by having an efficient flushing system at the summit of each sewer. There is no reason why the summits should be lower than elevation -2.0. Hence the inverts could be placed on a much steeper grade than 0.3 per 1,000 and greater discharging velocities obtained.

In a number of these sewers the mud and sludge deposits occupy almost 50 per cent. of their cubical contents. In the Clinton street sewer between Newark and First streets mud and sludge amounts to fully 75 per cent. of the sewer's volume, the sludge even rising to within 10 or 12 inches of the street surface in two of the manholes near First street. This sewer is almost completely stopped up, and the sewage is stagnant in every manhole.

The Adams street sewer between Newark and First streets is also in a very sluggish condition. At one point the invert has evidently settled over 3 feet, and about 70 per cent. of the sewer's volume is filled up with mud and sludge.

The sewers on Park avenue, Garden, Willow and Adams streets are brick sewers and may be termed in fair sanitary condition; their velocities of flow, however, are sluggish and the sewage heavily laden with suspended matters.

The Clinton street sewer, between First and Third streets, is a wooden box and is not in good condition. Between third and Fourth streets the sewer is of brick and in fair sanitary condition. As in the other sewers described, the current is sluggish and very little liquid sewage is flowing in them, particularly at the summits.

SUMMARY OF DATA AS TO THE PRESENT SEWERAGE WORKS.

The foregoing facts and conditions may be summarized as follows:

1.—About 71 per cent. of the city is now provided with sewerage facilities.

2.—The sewerage of that part of the city which lies more than about 10 feet above high tide is in general satisfactory.

3.—The sewerage of a part of the low level district is also satisfactory. The sewerage of other portions of this area can also be made to be satisfactory.

4.—Street flooding is very common as the result of the stoppages of sewers and clogging of catch basins, as well as by reason of the deficient capacity of certain sewers.

5.—The provisions for removing storm water and sewage from the low level districts of the city are entirely inadequate and improper.

6.—All the sewers in the low level districts not built upon a firm pile foundation show extensive settlement.

7.—Catch basins and many of the sewers themselves are badly clogged with deposits of dirt and filth, particularly those sewers which are not built upon pile foundations.

8.—The hand operated tide gates on the sewer outfalls are at times a detriment rather than a help to the proper operation of the sewers.

9.—The automatic tide gate on the Third street outfall appears to offer some advantages in the operation of the sewer, particularly at times when the tide rises more rapidly than the sewage fills up the sewer.

10.—Property owners, merchants and manufacturers, particularly those located in the parts of the city lying at low elevation, are greatly inconvenienced and damaged by the flooding of the streets, basements and ground floors of their buildings.

11.—Sewerage facilities are urgently needed throughout the Fifth Ward of the city, and much improvement is needed in the sewerage of the older and more built-up parts of the city.

12.—Better and more substantial construction methods should be used in the future sewerage work in Hoboken.

13.—Some of the older sewers can be utilized in the reconstruction of the sewerage system of Hoboken while others must be abandoned and rebuilt.

14.—The streets in the lower part of the city show extensive and continuous settlement. Satisfactory sewerage can not be secured for the low level districts of the city unless the established street grades are maintained. Property owners should be obliged to place their buildings at elevations corresponding to the established grades.

PART II.

BASIC DATA FOR THE DESIGN OF IMPROVED SEWERAGE WORKS.

POPULATION.

The satisfactory sewerage of Hoboken will involve the prompt removal and disposal of the sewage and storm water. The quantity of sewage to be taken care of and the rate of storm water run-off will depend on the population of the city and on its growth.

Population by Wards.—The population of Hoboken and its growth in recent years are given in Table 3, compiled from the State and U. S. Censuses.

TABLE 3.

Population and Density of Hoboken, by Wards.

Ward.		1900		1905		1910		Five year increase 1905-'10
No.	Acres	Population.	Density per acre	Population	Density per acre	Population	Density per acre	
1	104	.....	...	10,979	105	11,657	112	7.1%
2	231	.....	...	8,736	38	10,145	44	12.0%
3	127	.....	...	17,405	137	19,207	151	10.3%
4	113	.....	...	15,815	140	15,802	140	none.
5	262	.....	...	12,534	48	13,513	52	7.8%
T'tal	837	59,364	71	65,468	78	70,324	84	7.4%
10 year increase, 18½% (1900-1910).								

The above densities per acre in Wards Nos. 1 and 2 do not reflect the real density of population on account of the large area devoted to dock purposes in Ward No. 2, and the area devoted to railroad and dock purposes in Ward No. 1. The areas shown in the above table have been computed to the "exterior line for solid filling" as designated on the maps; and also include the areas occupied by the D., L. and W. passenger yards and train sheds.

In order to obtain, therefore, the net areas which could be devoted to sewer purposes, that portion of Ward No. 1 which is entirely covered by the D., L. & W. tracks, station etc., and the area between a line 100 feet east of River street and the "exterior line for solid filling," ought to be deducted because it is hardly probable that those areas will ever be devoted to anything but their present purposes.

In the case of Ward No. 2 the area between the Shore Railroad and the "exterior line for solid filling" is entirely devoted to railroad and dock purposes, and except for a depth of 100 feet on River street, between Third and Fourth streets, and 100-foot depth on Hudson street, between Eleventh and Fourteenth streets, this

whole area will probably never be used for any other purpose. Hence, in order to obtain a more definite and real density of the population in these two wards, the areas designated ought to be deducted from the area of the ward shown in the above table.

The area devoted to railroad and dock purposes in Ward No. 1 is 34 acres. Deducting this from the total area of 104 acres there remains 70 acres, on which in 1910 there was a population of 11,657, making the density of population really **167 per acre,** instead of the 112 per acre as shown in the table.

Deducting the dock area of 93 acres in Ward No. 2 from the 231 acres shown in the table, there results a net area of 138 acres, on which the population in 1910 was 10,145 or at the rate of 74 per acre, instead of 44 as shown in the table. A considerable area in Ward No. 2 is devoted to the purposes of the Stevens Institute, and this area, of course, is sparsely populated.

Deducting from the total area of the city the 127 acres devoted to dock and railroad purposes, there remains 710 acres, all of which could be made use of for residential and manufacturing purposes.

Ward No. 5 is the only portion of the city in which a large part of the available area for residential and manufacturing purposes is not made use of.

In order to obtain an estimate of what the future population may be, it is thought desirable to compute this from the actual density in one of the wards and then apply this density to the whole area available for population rather than to compute it from the rate of growth in past years. This seems to be a more rational basis, because if proper sewer and drainage facilities were constructed there can be no doubt that the whole available area would be soon occupied, owing to the advantageous commercial position Hoboken occupies.

For the actual area occupied, Ward No. 3 has the greatest density of population. Of the total area of 127 acres on which the density in 1910 was 151 per acre, 20 acres were unoccupied. Hence the actual density was 19,207 on 107 acres, or at the rate of 180 per acre.

Assuming, therefore, that the entire available portion of the city of 710 acres will eventually carry the same density as the actual density of Ward No. 3 in 1910 (180) the total maximum population of the city may reach 127,800.

In all the wards except No. 2 the population is of a mixed character and is generally housed in tenement buildings of from 4 to 5 stories high. It is considered that it would be very improbable that tenement houses in this district will ever be built much higher and certainly not for a long time to come. Practically the only way to increase the above figured maximum population would be by increasing the heights of the tenement houses. It is very doubtful

if this will occur within any reasonable time. The foundations of the present tenement buildings are probably not sufficient to stand any increase in height of the building; so if higher tenement houses were projected, an entirely new building would probably have to be designed and constructed. That this will be done in the immediate future, even on a small portion of the area, is hardly probable.

Where Future Increase in Population Can Occur.—In order to determine where the increase in population will occur when the maximum is reached, Table 4 has been prepared.

TABLE 4.

Table Showing the Maximum Increase of Population in Each Ward From That of 1910, if All the Available Area for Population Were Made Use Of.

Computed upon the **actual** density of the Third Ward in 1910.

Ward	Total area. Acres.	*Available area for population. Acres.	Density per acre 1910 on available area.	Probable maximum density.	Total increase when maximum is reached.
1	104	70	167	180	910
2	231	138	74	180	14,620
3	127	127	151	180	3,683
4	113	113	140	180	4,520
5	262	262	52	180	33,536
Totals	837	710	...	...	57,269

*Equals total area less that occupied by docks and Railroad yards.

It will be observed that the principal portion of the increase will occur in Wards Nos. 2 and 5. The possible increase in Ward No. 2, amounting to over 14,000, is entirely due to the sparsely populated area occupied by the Stevens Institute—all the other available area in this ward being practically built upon. This ward is located entirely upon the highlands of the city, where there is no difficulty with the sewerage and drainage problem. Undoubtedly the area occupied by the Stevens Institute will remain as it is at present without a material increase in population for many years, and it is highly improbable for this reason that any such increase as noted in the table for Ward No. 2 will occur—at least not for a very long time.

Areas Still Available for Population.—It will be observed that the areas available for population are almost entirely limited to those portions of the city which **do not** have sewerage or drainage facilities. Ward No. 5, where an increase of over 33,000 in popu-

lation could be obtained if the available area were built upon, has only 34 per cent. of its area sewered. Although the increase in population in Wards Nos. 3 and 4 is relatively a small proportion of the total, yet if proper drainage and sewerage facilities were constructed for the unoccupied areas, the increase in population would undoubtedly soon occur.

Table 5 has been prepared to show the area sewered in each ward:

TABLE 5.

Table Showing the Area in Each Ward Having Sewer Facilities.

Ward	Area, less that occupied by docks and R. R.	Area having sewer facilities.	Per Cent. of Total.	Probable increase in population.
1	70 acres	70 acres	100	910
2	138 acres	138 acres	100	14,620
3	127 acres	105 acres	83	3,683
4	113 acres	101 acres	90	4,520
5	262 acres	90 acres	34	33,536
Totals	710 acres	504 acres	71	

Note—The area served by the present 15th St. sewer has been neglected on account of its inefficiency.

Estimates of Future Population.—The estimated future population of Hoboken, by wards, therefore, would, on the foregoing assumptions, be as shown in Table 6.

TABLE 6.

Estimated Future Population of Hoboken.

Ward.	1910.	1920.	1930.	1940.
1	11,657	12,100	12,400	12,500
2	10,145	15,200	20,000	24,800
3	19,207	21,200	22,100	22,900
4	15,802	16,600	18,100	20,300
5	13,513	18,400	31,600	47,000
Total	70,324	83,500	104,200	127,500

QUANTITY OF HOUSE SEWAGE TO BE EXPECTED.

City sewage includes, in general, the liquid wastes from buildings, the ground water which leaks into the sewers through imperfect joints, or through breaks, and street or gutter water arising from rains, melting snow and street washing.

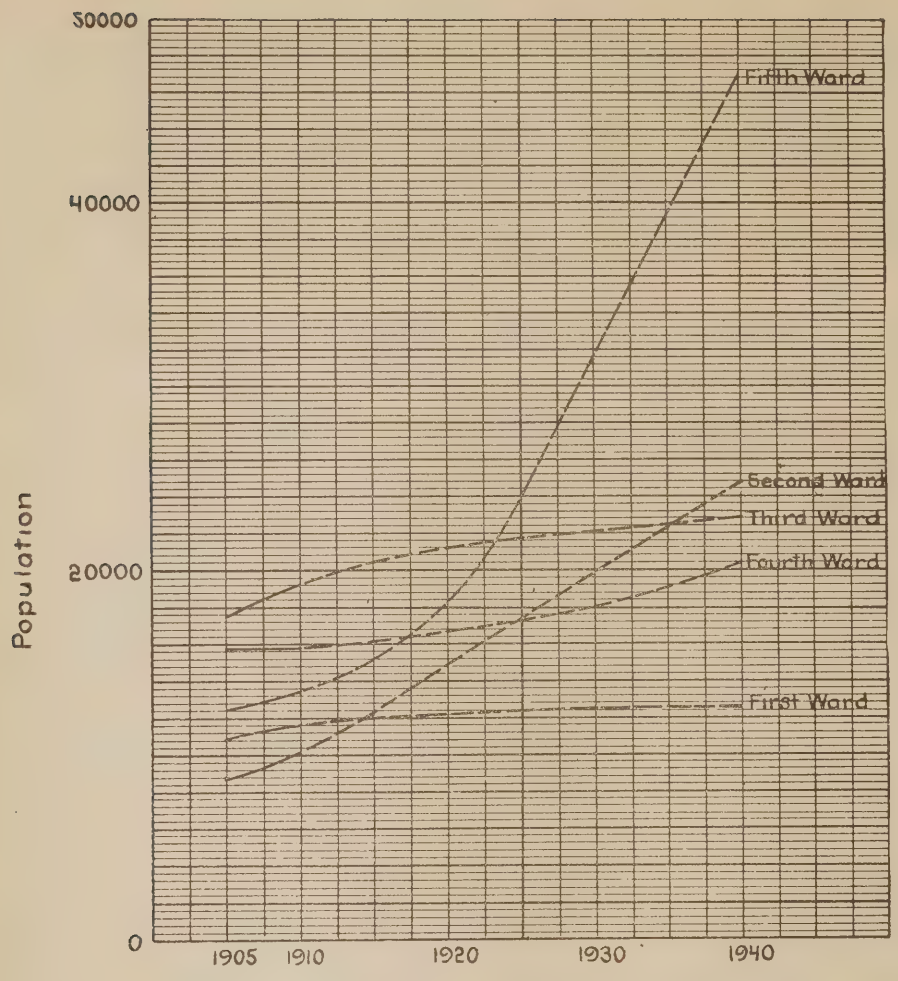
Water Consumption in Different Districts.—Usually the quantity of house sewage to be taken care of in a town is about equal to its water consumption. The character of the population supplied, however, has a great influence on the quantity of water used in different parts of a city. This is shown in Table 7, compiled from data col-

lected in New York City by the Department of Water Supply, Gas and Electricity some yeasr ago, and published in the reports of the Department. In the investigations referred to several large districts in New York City were cut off by shutting valves in the street mains so that all the water was fed to the district through certain known pipes, and was thus measured accurately as it passed into the district.

TABLE 7.

Water Consumption as Obtained by Pitometer Measurements in Various Districts of New York, by N. S. Hill, Jr., Chief Engineer, Department of Water Supply, Gas and Electricity.

District	Area Acres.	Resident Population.	Population per acre.	Consumption per capita. Gallons per 24 hours.
Medium dense tenement district (east side)..	70	38,906	553	37
Typical dense east side tenement	168	90,000	536	{ 60 55
Residence district; moderate cost flats, four and five story.....	174	32,200	185	54
Residence district; high cost apartments	58	10,164	175	75
Highest cost apartment houses and hotels, probably not transient	75	8,872	118	154
Typical east side tenement house district, with some water front uses by ferries and shipping	310	218,023	703	93
Harlem residence district; moderate cost apartments	196	43,800	223	112



Estimated Future Growth of Population of Hoboken, by Wards.

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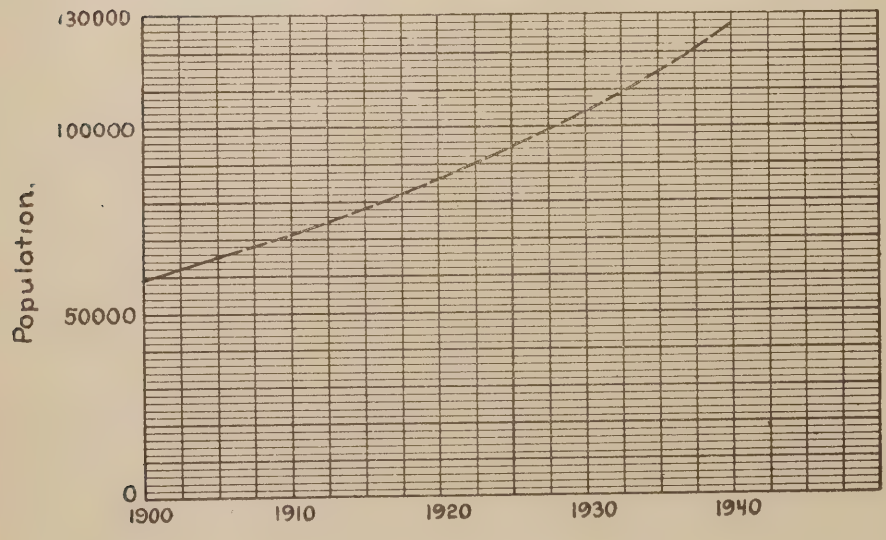


Estimated Future Growth of City of Hoboken N. J.

From the above it will be seen that the consumption of water per 24 hours per capita varied from 37 gallons in the medium tenement district on the East Side of New York to 154 gallons per capita in the district containing the highest cost apartment houses and hotels, and that in the typical East Side tenement district with water front uses and shipping it was about 93 gallons per capita, while in the Harlem residence district consisting of moderate cost apartment houses the consumption was about 112 gallons per capita per day.

For Hoboken conditions I assume, for the purpose of estimating the quantity of sewage to be taken care of, that the average daily water consumption will be about 100 gallons per capita.

Maximum Rates of Sewage Flow.—The sewage coming from the houses and buildings in a city does not get into the sewers at a uniform rate throughout the 24 hours. There is usually much less water used during the night time than during the day, and less on certain days of the week than on others, and less at certain seasons of the year than at others. It has been found, from measurements made in many cities, that ordinarily the maximum rate at which sewage finds its way into the sewers is at about twice the average rate of flow.

It is also customary to assume that the sewers will be called upon to accommodate more or less ground water. In some localities, even with great care in laying the pipes and in making tight joints, the quantity of ground water leaking into the sewers equals or exceeds the quantity of sewage coming from the buildings. At Hoboken, if the separate system of sewerage is employed, very liberal allowances will have to be made for leakage of ground water into the sewers, as practically all the sewers of the system would be laid at elevations below high tide.

Allowance for Infiltration of Ground Water.—Owing to the soft and yielding nature of the soil in the low level parts of Hoboken it is almost certain that local settlement will, in many places, cause joints in the sewers to open and allow the infiltration of considerable quantities of ground water into the sewers. I have no data on what may reasonably be expected, but assume provisionally that even with the greatest of care in laying the sewers the quantity of ground water percolating in through the joints would amount to at least half the quantity of sewage contributed from the same territory.

Sewers Should Provide for Ultimate Population.—For the separate system of sewers, that is, for sewers taking house sewage only, the sizes of the lateral sewers in the plans discussed herein have been proportioned so that running half full they will carry three times the average daily rate of sewage flow, and the main trunk sewers so that running three-quarters full they will carry twice the average daily rate of sewage flow. A reference to the population

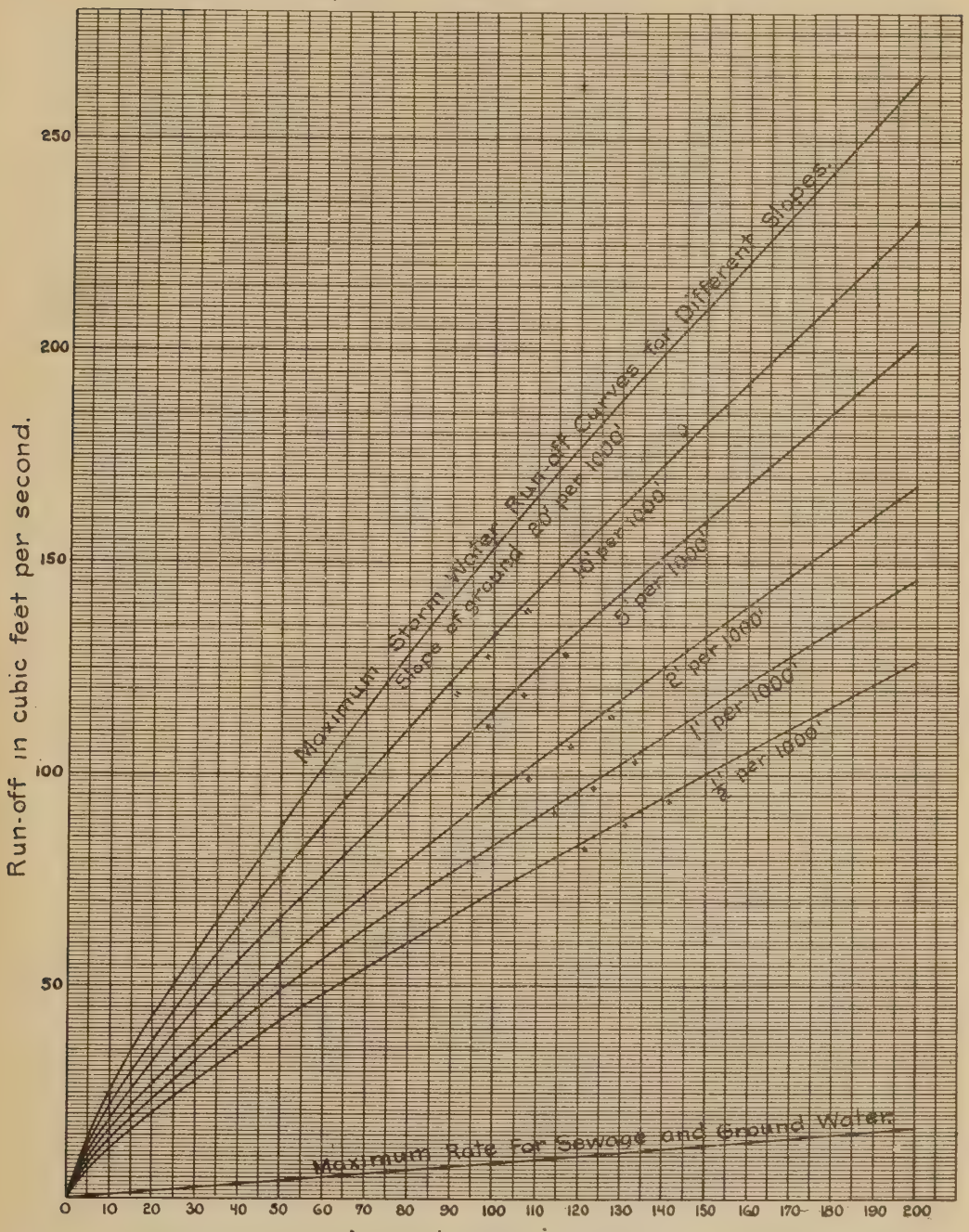
studies given above indicates that by about 1940, if the present rate of growth keeps up, all of the land available for building purposes will be built upon. This being the case, all the new sewers built from now on should have a capacity sufficient to provide for the ultimate population that will reside in their respective drainage areas. This condition has been kept in mind in the designs of all the sewers discussed and proposed in this report.

QUANTITY OF STORM WATER TO BE PROVIDED FOR.

Run-off.—The rate at which water reaches storm water sewers depends upon the slope, shape, area and imperviousness of the watershed, as well as upon the rate at which the rain falls. From two areas of the same size, the one which is steepest and most impervious and best shaped for the rapid concentration of all storm water to the lower end of the drainage area will naturally give the greatest run-off. Other things being equal, the greatest rate of run-off would result from the most intense rates of precipitation with the exception that the storms of greatest intensity in rate are usually short in duration from which circumstance it sometimes results that large areas give greater rates of run-off for smaller rainfalls lasting a considerable length of time than for more intense rainfalls lasting only a few minutes.

Diagrams Showing Run-off From Different Areas.—Many observations have been made and a good deal of experience has been had relative to the rates of run-off from different areas under different conditions. It is not necessary to review all the available information in this report. In Diagram 1 will be found a series of curves representing the quantities of storm water that may be expected to reach the Hoboken sewers per minute from different areas having different surface slopes. The diagrams are self-explanatory. The curves were deduced from a formula devised by MacMath from gaugings of sewers in St. Louis. The quantities that will be given by these diagrams are in excess of those which may be expected under present conditions, as they are based upon having all the streets paved and upon a large percentage of the area of the town being covered by roofs and paved court-yards.

Diagram Showing Estimated Run-off in Cubic Feet per Second, from Different Areas Having Different Surface Slopes. Hoboken N.J.


Run-off in cubic feet per second.
250
200
150
100
50
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Area drained, in acres.
Maximum Storm Water Run-off Curves for Different Slopes.
Slope of ground 20' per 1000'
10' per 1000'
5' per 1000'
2' per 1000'
1' per 1000'
½' per 1000'
Maximum Rate for Sewage and Ground Water.

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140 Nassau St. N.Y.

SYSTEMS OF COLLECTION.

There are two general systems of collecting sewage and conveying it to disposal points; these are called, respectively, the separate and the combined system.

Separate System.—In the separate system of sewerage two separate sets of sewers are provided, one for the removal of house or domestic sewage and the other for the removal of storm water.

Combined Systems.—In the combined system only one set of sewers is built and these accommodate not only the house sewage, but the storm water, both of which are conveyed together to the points of disposal.

Choice of System.—The choice of system depends on many matters. When the sewage has to be conveyed long distances from the city to the site of a purification plant, and when the storm water can, with impunity, be discharged into nearby water courses, the separate system is preferable, and the most economical. The separate system also usually proves to be the most economical where purification of the sewage is required, particularly if this purification be of intensive nature, or of a kind intended to produce a very pure effluent. Where the sewage can be disposed of into a large body of flowing water, with very little necessity for purification, and at points not far distant from the city, then usually the combined system is cheapest and most desirable.

Pumping vs. Gravity Discharge.—There are two general methods of getting rid of the sewage of Hoboken; one is to discharge all of it into the Hudson River by gravity, and the other is to resort to a pumping plan. Under the latter plan there would be two possible schemes, one to pump the domestic sewage and allow the storm water to go into the harbor by gravity, and the other to pump both the storm water and the sewage from the low level district. Both of these plans and modifications thereof, together with their costs, will be discussed in full hereinafter.

Effect of Tides on Sewage Discharge.—Hoboken occupies a unique position with regard to her sewerage, owing to the fact that a large percentage of the area of the town is but from 1 to 3 feet above high tide in the Hudson River, and that this low land lies back from one-half of a mile to a mile from the river front. Sewers built low enough to drain these low lands by gravity must necessarily lie between high and low tide, and cannot, therefore, have continuous flow at self-cleansing velocities throughout the 24 hours of each day. The rising tide will gradually slow down and finally stop the flow in the sewers and then, a short time after the tide has begun to fall, the flow will again start and reach its maximum when tide water has dropped below the invert of the sewer at the harbor line. Continuous discharge will then take place for three or four hours until the rising tide again repeats its operation of slowing

down and finally stopping the flow. These conditions are not favorable for maintaining the sewers in a clean condition for the reason that during the times when the velocity is checked down to less than about 1½ feet per second deposits will take place in the sewers; under some conditions these may become too solid to be again flushed out by the flowing sewage on the falling tide.

Pumping.—If a system of collection and disposal be adopted which involves pumping then all the sewers can be laid on sufficiently steep grades to keep themselves clean and free from deposits, but all the sewage would then require pumping to the harbor, and if the sewers were on the combined system the pumping capacity would have to be sufficient to pump out all the storm water during the maximum rainfall, as well as the sewage, or else storm water overflows would have to be provided to permit the excessive rates of flow to discharge directly to the harbor without pumping. Such an arrangement as this, of course, would give deep drainage, excepting during heavy rains, when the entire system would then be flooded to a level high enough to permit the storm water to overflow.

The storm water which will have to be taken out of town in the sewers must be discharged as rapidly as it falls in order to prevent the flooding of the streets and properties in the town.

Deep Drainage Not Feasible.—While it would be feasible, as an engineering problem, to provide a system of sewers that would give deep drainage for Hoboken there are certain features peculiar to Hoboken which render the advisability of this questionable. As has been stated before in this report, many of the large and fine buildings in Hoboken rest upon wooden piles, and these will remain safe and stable so long as the piles are kept submerged below the ground water level. If the ground water level were to be lowered below the present prevailing height then trouble would be sure to be felt in a comparatively short time by the rotting of the piles and of grillages, the crushing of the timber and the settlement of the buildings. If all the sewers and their connections were perfectly tight and would remain so there would be little likelihood of danger from this cause in securing deep cellar drainage. I am quite certain, however, that sewers can not be maintained in such a condition in Hoboken. Even though the main sewers were practically tight a large percentage of the house connections would certainly leak, owing to the settlement of the streets and, if the entire system were put on a pumping basis, the pumps would, during dry weather, quickly lower the ground water level throughout the entire district.

DISPOSAL OF THE SEWAGE.

Requirements.—The sewage of Hoboken must eventually find its way into the Hudson River. This river, however, in common with the whole of New York Harbor, is at times polluted to a very serious degree. The question has attracted much attention of late

years and has been the subject of several investigations and reports. The fouling of the waters and the shoaling of the harbor have forced the matter upon the attention of the U. S. Government, and the Secretary of War formulated, under the Federal laws, a policy of protection which is placed in the hands of the U. S. Engineer's Office for the port. No new large sewers can now be built to discharge sewage into the harbor of New York which will interfere in any way with the rights of the United States in these waters, and attempts to evade the regulations are promptly met by injunctions which are held in force until the authorities constructing the sewers enter into proper agreements with respect to the character of the sewage to be discharged into the harbor and its method of discharge. With these facts in mind no plan for the disposal of the Hoboken sewage could safely be followed that would not meet the requirements of the War Department in the matter of the degree of purification required for the sewage.

Extent of Treatment Necessary.—Hoboken, being situated upon the bank of the river, and having no other place to dispose of her sewage, is situated much the same as Manhattan and has greater rights to the digestive capacity of the harbor waters than other towns or communities not so situated. Under these conditions Hoboken is entitled to the advantage of her position and should not be required to go to the expense of purification further than would be necessary to prevent the silting up of the harbor, the creation of offensive odors and the prevention of unsightly discharges in the neighborhood of the piers and docks.

Reduced to briefest terms the minimum amount of purification necessary at the Hoboken outfalls would be the removal of sand and other heavy matters from the sewage, the removal of other objectionable floating matters, and the discharge of the effluent at the pierhead line and as deep below the surface of the harbor as practicable. The outfall works would, therefore, consist of small grit chambers for the removal of the heavy sediment, automatically cleaned screens for the removal of the floating matters, submerged outfalls reaching to the pierhead line for the discharge of the dry weather flow of sewage, and storm water overflows at the bulkhead line for relief during heavy rains.

PART III.

IMPROVEMENT OF THE SEWERAGE OF HOBOKEN.

Any plan for the improvement of the sewerage of Hoboken must take into account and utilize to the fullest practicable extent the sewers now in service, in addition to providing sewerage facilities for the parts of the city not now sewered.

CHANGES IN THE PRESENT SEWERAGE SYSTEM.

Reduction of Drainage Areas.—Inspections and investigations into the sizes and conditions of the existing sewers show that both the Ferry street and Third street outfall sewers are receiving too great a quantity of surface drainage, and at times become choked with water so as to cause sewage to run out upon the streets from the catch basins and manholes in the low parts of their drainage areas. To rectify this condition it is planned, in building the new sewers, to cut off from these two outfalls some of the area at present tributary to them, and take the storm water thus diverted into the new sewer discharging on Fifth street.

Improvement of Outfalls.—The Ferry street sewer has at present two outfalls, one on the line of Park avenue, in the canal, and the other into the Hudson River from the end of the first pier south of the Ferry terminal of the D., L. & W. Railroad. Owing to its position the greater part of the sewage draining towards Ferry street discharges into the canal on the line of Park avenue and as a consequence the canal is extremely foul. In the reconstruction of the existing sewers it is intended to stop the dry weather flow from discharging at the Park avenue outlet, abandon the outfall, constructing works in Ferry street that will divert all the dry weather flow down Ferry street and through a cross-connection to the Hudson River outlet of the Newark street sewer, but providing for a storm water overflow at Park avenue. This will materially improve the condition of the canal. Instead of having the hand-operated gates at Park avenue, it is proposed to substitute automatic tide gates on the storm water overflow at this point. It is also proposed to dispense with the hand-operated gates at Ferry and Hudson streets and place there mechanical screens and a grit chamber, with automatic tide gates on the outfalls.

The Newark street outfall is to be improved by placing a grit and screen chamber at the outfall, providing a storm water overflow into the head of the slip south of the first Hamburg-American line pier, and extending the outfall for dry weather flow out to the head of this pier, so as to discharge the ordinary flow of sewage into deep water at the pierhead line.

The Third street outfall is to be improved by building a grit chamber with automatic screens in River street, between Third street and the present automatic tide gate.

In addition to the changes in the outfalls above mentioned certain of the old sewers now in use are in such bad condition that they will have to be rebuilt in order to be of any service.

Flushing.—It is also intended to provide large automatic flush tanks at the heads of all the sewers, these to be supplied with harbor water and to discharge automatically at low tide, the tanks being large so as to assure good velocities of flow throughout the entire system.

The necessary changes will be detailed and their costs stated in the estimates for the several different plans given hereinafter for improving the sewerage of Hoboken.

FEASIBLE PLANS FOR PROVIDING IMPROVED SEWERAGE FOR HOBOKEN.

General Description of Plans.

The different plans which local conditions indicate to be feasible for improving the Hoboken sewerage system are seven in number, as follows:

Plan A.—A combined system of new sewers to receive the sewage and storm water of the unsewered part of the city, the rebuilding of many of the existing sewers in the older part of the city, the extension of the outfall pipes to the pierhead line in the case of all the sewers, the provision of flushing arrangements for both the new and old sewers, the abandonment of the Park avenue outfall of the Ferry street sewer and provisions at that point for a storm water overflow to the canal, the provision of automatic tide gates for the Ferry street and Newark street outfalls, as well as for the new sewers and the extension of the Newark street outfall to the pierhead line. (This plan is the cheapest that could be devised for Hoboken. It does not, however, provide a sufficient amount of purification to be acceptable. The estimate is given simply to show the minimum expense which will provide satisfactory sewerage for Hoboken irrespective of the requirements as to discharging the sewage into the harbor).

Plan B.—A combined system of new sewers to receive the sewage and storm water of the unsewered part of the city, the rebuilding of many of the existing sewers in the older parts of the city, the provisions for the flushing arrangements for both old and new sewers, the extension of the

outfalls, improvement of the Newark street outfall, storm water overflow at Park avenue from the Ferry street sewer and the placing of grit chambers and automatically cleaned screens and automatic tide gates, at all outfalls. (This is the plan recommended).

Plan C.—A combined system of sewers to receive the sewage and storm water from the unsewered part of the city, the rebuilding of portions of the present system, the provision of flushing arrangements for all sewers, the extension of the outfalls to the pierhead lines, the provision of the storm water overflow at Park avenue, the improvement of the Newark street outfall, the provision of coarse screens, grit chambers and settling basins near the outfall of each of the sewers, the provision of tide gates at all outfalls for both dry weather and storm flows, and the provision of small electrically operated pumping stations at each outfall with sufficient capacity to pump the dry weather flow of sewage from the settling tanks to the outfalls. (In this plan the pumping of the dry weather flow of sewage at each of the outfalls will give better velocities of flow in the sewers and relieve somewhat the expense of the elaborate flushing provisions made in the preceding plans. During rainstorms, however, the pumps would not have capacity sufficient to discharge the storm water flow and the system would then fill up the same as under Plans A and B. During such time, therefore, Plan C would offer no advantages over Plans A and B with respect to possible cellar drainage).

Plan D.—A combined system of sewers for the entire city, those for the low level district being arranged so as to lead the sewage and storm water to a pumping station from which it would be discharged by pumps. The high level districts would discharge through combined sewers by gravity as in Plans A and B. The outfalls would be provided with screens and grit chambers, and the outfall for dry weather would be extended to the pierhead lines. Provisions would be made also for flushing all sewers and portions of the old sewers would be rebuilt and improved as under Plans A and B.

Plan E.—A separate system of sewers for the entire city using the present sewers for storm water only and building new storm sewers for the unsewered part of the city. Under this plan the sewage would be conducted to ejector stations, so located that each would receive the sewage from about 40 acres, the sewage to be pumped by compressed air to a central power and disposal plant in the vicinity

of Adams and Ninth streets. The existing sewers and the new storm water sewers would be provided with flushing arrangements, and modern settling basins and methods of sludge handling would be provided near the power plant. The existing sewers would be improved and made suitable for storm water sewers as under Plans A and B.

Plan F.—A separate system of sewers as in Plan E excepting that instead of using ejector stations all the sanitary sewage would be conveyed to an electrically operated central pumping plant to be located in the vicinity of Adams and Seventh streets or other suitable locality. The sewage would be received in improved settling tanks with modern methods of sludge handling, and all storm sewers would be provided with flushing arrangements and the existing sewers, to be used for storm water only, would be improved as under Plans A and B.

Plan G.—A separate system of sewers as in Plan E excepting that instead of using ejector stations to receive the sewage from each 40 acres of the city small automatic electrically operated pumping stations would be established at points such that each would receive the sewage from about 30 acres, the sewage from these small stations to be received in settling basins placed underneath the streets, and pumped therefrom to the storm water sewers. The arrangements for taking care of the storm water would be the same as in Plans E and F, and provisions would be made for the flushing of the storm water sewers as in all the other plans.

DETAILED DESCRIPTIONS OF THE DIFFERENT PLANS.

PLAN A.

Works to Be Executed.

This system would consist of a new combined gravity flushing system, for the parts of the city not sewered, discharging into the harbor, and the rebuilding of those portions of the present sewers which are at present unfit for service; the flush tanks would be supplied with river water flowing thereto by gravity through pipes laid underneath the sewers. The principal sewers would be as follows:

A trunk sewer in Fifteenth street discharging at the pierhead line at Fourteenth street.

A trunk sewer in Eleventh street discharging at the pierhead line at Eleventh street.

A trunk sewer in Seventh street discharging at the pierhead line at Fifth street.

The rebuilding of the present system. (Includes building of new sewers in Harrison and Marshall streets where there is none at present).

Capacities of Sewers.

Fifteenth Street Trunk Sewer.—The Fifteenth street trunk drains 77 acres in Hoboken and 30 acres in West Hoboken. The maximum discharge from the two areas I estimate to be 61 cubic feet from Hoboken and 20 cubic feet from West Hoboken, or a total of 81 cubic feet per second per acre.

The least gradient for discharge will occur when a storm comes at high tide. It has been assumed that during maximum storms at high tide the sewage may rise to elevations -|- 3 without flooding the streets. Hence the gradient will be 0.6 per 1,000 in the total length of about 5,000 feet. Therefore, we have for the Fifteenth street trunk:

Slope 0.6 per 1000.

Discharge required 81 cubic feet per second.

Eleventh Street Trunk Sewer.—The Eleventh street trunk sewer should discharge 80 cubic feet per second from Hoboken (area 81 acres) and 13 cubic feet from West Hoboken (area 15 acres). Hence for the Eleventh street trunk:

Slope 0.6 per 1,000.

Discharge required 93 cubic feet per second.

Seventh Street Trunk Sewer.—The Seventh street trunk will drain 110 acres in Hoboken at the rate of 78 cubic feet per second, and 12 acrs in Jersey City, at the rate of 10 cubic feet per second. Hence for the Seventh street trunk:

Slope 0.45 per 1,000.

Discharge required 88 cubic feet per second.

Third Street Trunk Sewer.—The present Third street trunk sewer which now drains 146 acres, will in the improved plan drain 100 acres. It is assumed that the sewage may rise to elevation -|- 2, instead of -|- 3 as in the case of the new trunk sewers, on account of the established grades being one foot lower throughout this district. The discharge will be 67 cubic feet per second, and the slope 0.35 per 1,000, requiring a 66-inch circular sewer. The present sewer is 60 inches in diameter for some distance near the discharge end.

Ferry Street Sewer.—The present Ferry street drainage area of 205 acres will be reduced in the new system to 181 acres; and it is thought that reduction will result in not over-charging the present sewer.

The collector systems for Plan A have been designed so that each drainage area will have its outfall independent of the other; i. e., there will be no connection between the different drainage systems as in the present system.

Special Features of Design.

Flushing.—In order to secure good dry weather flows in these sewers it will be necessary to flush the collectors at their summits. It is proposed to accomplish this by flush tanks of about 500 cubic feet capacity located at the summit of each collector, these tanks to be fed by pipes leading from the harbor and the flushing to be done automatically when the ebb tide reaches elevation -3.5.

Main Collectors.—The collectors south of the trunk sewers drain an area of 2.7 acres requiring a discharge of 4.2 cubic feet per second.

The collectors north drain an area of 5.4 acres, requiring a discharge of 7.1 cubic feet per second.

Sewer Sections.—A section having a width of 7 feet and a height of 4 feet 9 inches has been designed for the new trunk sewers at their outfall ends; it has been assumed that the flow line will rise to within 6 inches of the top.

Wetted perimeter	12.5	feet.
Area of section	23.6	square feet.
Velocity	4.4	feet per second.
Discharge	104.	cubic feet per second.

The above section has been diminished to a width of 4 feet at the upper end of all trunk sewers, the uniform height of 4 feet 9 inches being maintained, throughout.

REBUILDING EXISTING SEWERS.

Conditions and Recommendations.

Note:—All the present sewers north of Seventh street are to be used in the collector system of the Eleventh and Seventh street trunk sewer, except those noted to be rebuilt under the Seventh street trunk.

Garden street, between Ferry and Seventh. Brick sewer; fair sanitary condition; will need flushing. (To be used).

Park avenue, between Ferry and Newark and First and Seventh. Brick sewer; fair sanitary condition; will need flushing at First and Seventh. (To be used).

Willow avenue, between Ferry and Seventh. Brick sewer; fair sanitary condition; will need flushing at Second and Seventh. (To be used).

Clinton street, between Newark and Fourth and Fifth and Ninth. Wooden box sewer between Newark and First in bad condition. Wooden box between First and Third in fair condition. Brick sewer between Third and Fourth in fair condition; will need flushing at Fourth. Brick sewer between Fifth and Seventh in fair condition; will need flushing at Seventh. Brick sewer between Seventh and Ninth in bad condition; has settled. (New sewer required between Newark and Third and between Seventh and Ninth—the others to be used).

Grand street, between Newark and Eighth. Wooden box sewer between Newark and First in bad condition. Brick sewer between First and Eighth in fair sanitary condition, but some settlement; will need flushing at Second and Seventh. (New sewer required between Newark and First and Seventh and Eighth—the others to be used).

Adams street, between Newark and Seventh. Wooden box sewer between Newark and Second in fair sanitary condition, but has settled. Brick sewer between Second and Third in fair sanitary condition, but needs flushing. Brick sewer between Third and Seventh in good sanitary condition, but will need flushing at Seventh. (New sewer required between Newark and Second—the others to be used).

Jefferson street, between Third and Seventh. Brick sewer in fair condition, but has settled between Fifth and Seventh; will need flushing at Seventh. (New sewer required between Fifth and Seventh; the remainder to be used).

Madison street, between Ferry and Ninth. Brick sewer in fair condition, but has settled some; will need flushing at Second and at Seventh. (New sewer required between Third and Ninth; the remainder to be used).

Monroe street, between Ferry and Eighth. Brick sewer in fair condition between Ferry and Second, but bad condition with settlement between Second and Eighth. Will need flushing at Second and Seventh. (New sewer required between Second and Eighth—the remainder to be used).

Jackson street, between Newark and Fifth. Wooden box sewer between Newark and First and brick sewer between First and Fifth; both in bad condition and have settled. (New sewer required).

Harrison street, between Newark and Fifth. Brick sewer in fair condition between First and Second. No other sewers on this street. (Build new sewers, but the present one to be used).

Marshall street, between Ferry and Fifth. There are no sewers on this street. (Build new ones).

Newark street, between Willow and City Line. Wooden box sewer in bad condition; much settlement. (New sewer required).

First street, between Park and Marshall. Wooden box sewer between Park and Jefferson. Concrete sewer between Jefferson and Marshall; both in fair condition. (Abandon the portion between Park and Jefferson and use 8-inch laterals to take local sewage; the Clinton, Grand and Adams street sewers to discharge into the Newark street sewer from Second street).

Third street, between the outfall and Madison. Brick sewer in fair condition except between Jefferson and Madison. This portion is probably a wooden box. It has settled very much at Madison and probably from there to Jefferson. No manholes between these streets. (New sewer required between Jefferson and Madison).

Ferry street, between Hudson and Jackson. Brick sewer in good condition. (To be used).

ESTIMATES OF COST OF CONSTRUCTION AND OPERATION.

Combined system for entire city discharging into harbor by gravity, including the rebuilding of parts of existing sewers, extending outfalls for dry weather flow to pierhead line and providing flushing arrangements for all sewers. (No screening or grit removal).

Estimated Cost of Construction.

Fifteenth street trunk sewer and all branches	$135,853.00
Eleventh street trunk sewer and all branches	127,053.00
Seventh street trunk sewer and all branches	135,043.00
Rebuilding present sewers, in part	148,608.00
	$546,557.00
Engineering and contingencies, 15 per cent	81,983.00
	$628,540.00

Estimated Annual Cost of Operation and Maintenance.

Interest on $628,540.00 at 4½ per cent		$28,284.00
Sinking fund ½ per cent		3,143.00
Maintenance:		
Cleaning catch basins	$1,600.00	
Repairs	200.00	
Inspections and water for flushing	1,200.00	3,000.00
		$34,427.00

PLAN B. (Sheet No. 3.)

Description.—Combined system for entire city discharging into harbor by gravity, and identical with Plan A except for the additional provision of grit chambers and automatically cleaned screens at all outfalls.

Estimated Cost of Construction.

Fifteenth street sewer and all branches	$142,853.00
Eleventh street sewer and all branches	134,053.00
Seventh street sewer and all branches	142,043.00
Rebuilding present sewers, in part	169,608.00
	$588,557.00
Engineering and contingencies, 15 per cent	88,283.00
	$676,840.00

Estimated Annual Cost of Operation and Maintenance.

Interest on $676,840.000 at 4½ per cent		$30,457.00
Sinking fund, ½ per cent		3,384.00
Maintenance:		
Cleaning screens and basins	$2,000.00	
Repairs	200.00	
Inspections and flushing water	1,200.00	
Power for operating screens	900.00	4,300.00
		$38,141.00

PLAN C.

Description.—Combined system for entire city, as in Plan B, except that each trunk sewer discharges into an underground settling basin near the water front having an overflow arranged so that the dry weather flow of sewage would be pumped from the tank, but storm water would discharge directly to the harbor without pumping.

Estimated Cost of Construction.

Fifteenth street sewer and branches	$164,186.00
Eleventh street trunk sewer and branches	155,386.00
Seventh street trunk sewer and branches	163,376.00
Rebuilding present sewers	233,609.00
	$716,557.00
Engineering and contingencies, 15 per cent	107,483.00
	$824,040.00

Estimated Annual Cost of Operation and Maintenance.

Interest on $824,040.00 at 4½ per cent		$37,082.00
Sinking fund, ½ per cent		4,120.00
Maintenance:		
Catch basins	$1,600.00	
Repairs	200.00	
Inspections and flushing water	1,200.00	
Cleaning settling tanks	800.00	
Superintendence	2,000.00	
Power	4,000.00	
Labor	2,000.00	11,800.00
		$53,002.00

PLAN D.

Description.—Combined system for entire city arranged so that the sewage and storm water from high level districts would discharge into harbor by gravity, but that from the low level districts would be collected to a pumping station and pumped thence to the harbor. Automatically cleaned screens and grit chambers on all outfalls.

Estimated Cost of Construction.

New collector system, pumping station and trunk sewers	$542,197.00
Rebuilding present sewers, in part	163,200.00
	$705,397.00
Engineering and contingencies, 15 per cent	105,808.00
	$811,205.00
Land	2,000.00
	$813,205.00

Estimated Annual Cost of Operation and Maintenance.

Interest on $813,205.00 at 4½ per cent		$36,594.00
Sinking fund, ½ per cent		4,066.00
Maintenance:		
Superintendence	$2,000.00	
Cleaning catch basins	1,600.00	
Repairs and depreciation	2,400.00	
Labor	4,200.00	
Power	22,560.00	
Oil waste and supplies	500.00	33,260.00
		$73,920.00

PLAN E.

Description.—Separate systems of sewers for storm water and for dry weather flow, using Plan B for surface drainage, and using ejector stations on each 40-acre area with central power and disposal plants for dry weather flow.

Note:—The ejector and pumping systems (Plans E, F. and G) include the portion of the city **west** of a line midway between Bloomfield and Garden streets, **except** the area north of Eleventh street, between Bloomfield and Park avenue. Total area 494 acres.

Sewerage Districts and Disposal Plant.—For this plan the city has been divided up into 40-acre areas with an ejector station in the centre of each, and all discharging through a central main to a disposal plant, in the vicinity of Adams and Ninth streets, consisting of settling basins of modern type for efficient sludge digestion. A central compressed air plant is also to be located at the same point.

The sewers would be from 8 inches to 12 inches in diameter, on self-cleansing grades. When running half full the velocities would range from 2 to 2.6 feet per second.

Ejector Stations.—Each ejector station should have a maximum rate of discharge of 36,000x40=1,440,000 gallons per day, or 1,000 gallons per minute. It is proposed to use two ejectors each with a capacity of 750 gallons per minute at each station.

Compressor Plant.—The compressed air plant has been designed to produce 500 cubic feet free air per minute, compressed to about 30 pounds, for each ejector station. There being 13 ejector stations, the capacity needed is 6,500 cubic feet.

Three compressors similar to the Ingersoll Class D—1, belt driven type would be required; capacity of each 3,245 cubic feet at 25-30 pounds pressure, together with 3 electric motors each of 300 H. P. The plan is designed to run on power to be purchased of the Public Service Corporation.

ESTIMATED COSTS OF CONSTRUCTION AND OPERATION.

(Separate systems of sewers for sewage and storm water. Sanitary sewers to be collected to ejector stations and delivered to central power and disposal plant. New storm water sewers in present unsewered district, and reconstruction of existing sewers to be identical with Plan B, except for parts rendered unnecessary.)

Estimated Cost of Construction.

Fifteenth street storm sewer and branches	$125,553.00
Eleventh street storm sewer and branches	119,053.00
Seventh street storm sewer and branches	133,343.00
Rebuilding present sewers	140,008.00
New sanitary sewers	227,240.00
Disposal works	103,740.00
Ejector and central pumping works	129,330.00
Reconnecting house drains, etc	46,930.00
	$1,025,197.00
Engineering and contingencies	153,778.00
Land	35,000.00
	$1,025,197.00

Estimated Annual Cost of Operation and Maintenance.

Interest on $1,213,975.00 at 4½ per cent		$54,629.00
Sinking fund, ½ per cent		6,070.00
Maintenance:		
Superintendence	$2,000.00	
Cleaning catch basins	1,600.00	
Repairs and depreciation	1,800.00	
Inspections and flushing water	1,200.00	
Labor	4,200.00	
Power	27,600.00	
Oil waste and supplies	500.00	
Sludge	800.00	39,700.00
		$100,399.00

PLAN F.

Description.—Separate systems of sewers for storm water and for dry weather flow, using Plan B for surface drainage, and using a pumping system for dry weather flow with central pumping and disposal plants. Total area from which sewage would be pumped 494 acres.

Collecting System.—In this system a main trunk sewer for house sewage would extend on Adams street from First to Fourteenth street with collectors discharging into it from both sides every two blocks. Each of these collectors would gather the sewage from 21 to 30 acres. The sewers would be from 8 inches to 18 inches in diameter, on self-cleansing grades. When running half full the velocity would range from 2¼ to 2¾ feet per second.

Location of Central Works.—The central pumping plant would be located in the vicinity of Adams and Seventh streets (Block No. 90) on the line of the trunk sewer, and the sewage would be pumped into improved settling tanks close by. The effluent from the tanks would be discharged into the Seventh and Eleventh street storm trunk sewers and the sludge be carted away. The elevation of the sewage in the settling tanks has been assumed at +6. The Adams street trunk sewer invert would be at elevation —12.3 at the pump well, making the pump lift about 18 feet.

Capacities.—The trunk sewer to the south of the pumping plant would drain 294 acres, and that to the north 200 acres. If the maximum rate of discharge of 200 gallons per capita (36,000 gallons per acre) on the small collector areas is a reasonable rate, then it would seem that on the large areas, the maximum rate could be reduced to say 75 per cent. of that amount, or 27,000 gallons per acre. This latter rate has been used in the design for the trunk sewer and the pumping plant. Hence the total maximum rate of discharge for the trunk sewer would be 5,400,000 gallons for the north branch and 7,938,000 for the south branch. These volumes require a 30-inch circular sewer for the north branch and 36-inch circular for the south branch, both running ¾ full on a grade of 0.6 per 1,000. The velocity would be about 2½ feet per second.

Pumping Plant.—The pumping plant has been designed for the maximum rate of discharge for both branches of the trunk sewer of 13,338,000 gallons per day (9,300 gallons per minute). As the minimum discharge will probably be less than half the maximum, the pumping capacity has been divided into different units, at the same time providing sufficient capacity in case one of the units should be out of service. The design, therefore, is based on two 12-inch centrifugal pumps each of 4,200 gallons capacity per minute, and one 15-inch centrifugal pump of 7,000 gallons per minute

capacity, each unit driven by an electric motor. Current to be purchased.

Disposal Plant.—The disposal plant would be located close to the pumping plant on Block No. 90 or at some other suitable location. The sewage in the tanks is assumed to stand at elevation -|- 6 (about 2 feet above the established grade of the streets). The capacity required would be at the rate of 558,000 gallons per hour, and the estimate is based on ten tanks each with a capacity of 56,000 gallons per hour. This would require the tanks to be 27 feet in diameter and about 28 feet deep, the bottom being at elevation about —22. The ground area covered by the disposal plant would be about 2 acres, or just about the area of Block No. 90.

ESTIMATED COST OF CONSTRUCTION AND OPERATION.

(Separate systems of sewers for sewage and storm water. All sanitary sewage to be collected to central pumping station and disposal plant and be pumped thence to the harbor. Storm sewers the same as in Plan E.)

Estimated Cost of Construction.

Fifteenth street storm sewer and branches	$125,553.00
Eleventh street storm sewer and branches	119,053.00
Seventh street storm sewer and branches	133,343.00
Rebuilding present sewers	140,008.00
New sanitary sewers	320,119.00
Disposal works	103,740.00
Central station	13,460.00
Reconstructing house drains	46,930.00
	$1,002,206.00
Engineering and contingencies, 15 per cent	150,331.00
	1,152,537.00
Land	35,000,00
	$1,187,537.00

Estimated Annual Cost of Operation and Maintenance.

Interest on $1,187,537.00 at 4½ per cent		$53,439.00
Sinking fund, ½ per cent		5,938.00
Maintenance:		
Superintendence	$2,000.00	
Cleaning catch basins	1,600.00	
Depreciation and repairs	900.00	
Inspections and flushing water	1,200.00	
Pumping:		
Labor	4,200.00	
Power	6,360.00	
Oil waste, etc	500.00	
Sludge disposal	800.00	17,560.00
		$76,937.00

PLAN G.

Description.—Separate systems of sewers for storm water and for dry weather flow, using Plan B for surface drainage and a pumping system for dry weather flow with pump and disposal plants for every 30-acre area. Total area to be pumped 494 acres.

Collection System.—In this system the city has been divided up into 30-acre areas and a disposal and pumping plant built in the centre of each. The collectors would be similar to those for the ejector system. (Plan E). The sewage would be discharged into settling tanks at the street intersections. The effluent from the tanks would be discharged into the storm sewers by means of centrifugal pumps run by electric motors.

The maximum rate of sewage flow on the 30-acre areas is assumed to be 18,000 gallons per acre, or 45,000 gallons per hour.

Disposal Works.—Two tanks 20 feet in diameter and 28 feet deep would be used at each point. The elevation of the sewage in the tank would be 7.5 and the bottom of the tanks would be at elevation —35.5. The street level would be about 10 feet above the sewage elevation.

Pumping Plants.—Two six-inch centrifugal pumps (capacity 1,000 gallons per minute) driven by electric motors would be installed in a separate pump chamber located close to or above the sewage in the tanks.

ESTIMATED COST OF CONSTRUCTION AND OPERATION.

(Separate systems of sewers for sewage and storm water. Sanitary sewage to be collected at several small automatic pumping stations and settling basins under the streets and pumped thence to the storm sewers. New storm sewers and reconstruction of existing sewers the same as in Plan E.)

Estimated Cost of Construction.

Fifteenth street storm sewer and branches	$125,553.00
Eleventh street storm sewer and branches	119,053.00
Seventh street storm sewer and branches	133,343.00
Rebuilding present sewers	140,008.00
New sanitary sewers	227,240.00
Pumping station	28,158.00
Disposal works	108,680.00
Connection of house drains	46,930.00
	$928,965.00
Engineering and contingencies, 15 per cent	139,335.00
	$1,068,300.00

Estimated Annual Cost of Operation and Maintenance.

Interest on $1,068,300.00 at 4½ per cent		$48,074.00
Sinking fund, ½ per cent		5,341.00
Maintenance:		
Superintendence	$2,000.00	
Cleaning catch basins, etc	1,600.00	
Repairs and depreciation	1,000.00	
Inspections and flushing water	1,200.00	
Labor	2,000.00	
Power	17,160.00	
Oil waste supplies, etc	800.00	25,760.00
		$79,175.00

PART IV.

SUMMARY AND RECOMMENDATIONS.

In arriving at a decision as to which of the foregoing plans will be most suitable for adoption they should be compared as to their costs of construction and operation, as to their fulfillment of the sanitary requirements and as to the effect of their operation on the lowering of the ground water levels throughout the city, and that plan should be chosen which best suits all the conditions.

As is usually the case in such investigations no one plan stands first in satisfying all the requirements; one may be best in some respects and not as good in others.

COMPARISONS AS TO COSTS OF CONSTRUCTION AND OPERATION.

The costs of construction and operation of all the different plans are given in the following tables:

SUMMARY OF ESTIMATED COSTS OF CONSTRUCTION.

Plan.	Construction Costs.	Engineering, Etc. 15%	Land.	Total.
A	$546,557.00	$81,983.00	.....	$628,540.00
B	588,557.00	88,283.00	.....	676,840.00
C	716,557.00	107,483.00	.....	824,040.00
D	705,397.00	105,808.00	$2,000.00	813,205.00
E	1,025,197.00	153,778.00	35,000.00	1,213,975.00
F	1,002,206.00	150,331.00	35,000.00	1,187,537.00
G	928,965.00	139,335.00	.....	1,068,300.00

SUMMARY OF ANNUAL COSTS OF OPERATION.

Plan.	Interest 4½%.	Sinking fund ½%.	Maintenance & operation.	Total.
A	$28,284.00	$2,143.00	$3,000.00	$34,427.00
B	30,457.00	3,384.00	4,300.00	38,141.00
C	37,082.00	4,120.00	11,800.00	53,002.00
D	36,594.00	4,066.00	33,260.00	73,920.00
E	54,629.00	6,070.00	39,700.00	100,399.00
F	53,439.00	5,938.00	17,560.00	76,937.00
G	48,074.00	5,341.00	25,760.00	79,175.00

It will be seen that the four plans on the combined system A, B, C and D cost less to build and operate than the three on the separate system and that plans A and B cost less, in both particulars, than plan C. The choice, therefore, with respect to costs of construction and operation would be either A or B, depending on which of these best fulfills the other requirements.

COMPARISON AS TO FULFILLMENT OF SANITARY REQUIREMENTS.

With respect to the completeness of the treatment of the sewage the three plans on the separate system, E, F and G, are better than plans A, B and D on the combined system, but not better than C. Plans E, F, G and C include settling tanks and screens, while B and D include the somewhatless efficient grit chambers and screens. A can be left out of consideration in this comparison as no treatment is contemplated thereunder, and its adoption would not be permissible. Under the conditions stated in Part II., however, either B or D would give a good enough effluent to be discharged in the manner proposed, and the more expensive plans E, F, G and C would not, therefore, be justified. Plan B, therefore, would be the proper selction with rspect to the fulfillment of the sanitary requirements.

COMPARISON WITH RESPECT TO THE EFFECT OF THE OPERATION OF THE PLANT ON THE LOWERING OF THE GROUND WATER LEVEL.

Plans D, E, F and G all include the laying of deep sewers leading to wells from which the sewage would be raised by pumps and discharged into the harbor. Plans A, B and C contemplate the discharge of the sewage into the harbor by gravity, the sewers being but little deeper than the existing sewers. Under these three latter plans there would be no danger of lowering the ground water below the present prevailing levels. Under the four first named plans it is probable that on account of the settlement of the house drains and the sewers themselves leaky joints would develop extensively and result in the permanent lowering of the ground water, particularly in the districts away from the river. Under local conditions it would be almost impossible to prevent these breaks from occurring, and, with the continuous removal of the liquids from the deep sewers by the pumps it would not be long before the water plane would begin to fall. My observations, from time to time, of excavations in various parts of the city, indicate that the ground water level fluctuates with the rise and fall of the tide for a short distance back from the river front, but that in the meadow district such influences are hardly noticeable. Considering safety from interference with ground water levels, therefore, either plan A, B or C should be selected.

RESUME AND RECOMMENDATIONS.

Since Plan A would not give a satisfactory effluent it may be disregarded in the final comparison. Plan B, therefore, appears to be the least expensive of the acceptable plans, to build and operate, and to be capable of giving as good an effluent as the conditions

require. Plan B also can be operated without interfering with the ground water levels of the meadow district, which, by reason of its other advantages makes it preferable to the more expensive Plan C. I, therefore, recommend Plan B for your adoption.

GENERAL DISCUSSION OF PLAN RECOMMENDED.

Street Grades in Meadow District.—In working out a plan for the drainage and sewerage of Hoboken it is essential that the established system of street grades be enforced in the meadow district. A large part of this district lies but about one foot above high tide at present. This is too low to permit of the development of the property for any purposes unless the ground water level could be lowered by pumping. This, for the reasons stated elsewhere herein, is not permissible owing to the great value of the buildings and industries that would be affected adversely thereby. The only alternative, therefore, is to raise the streets in accordance with the established grades. This will give a minimum elevation for the street surface of from 3.5 feet to 5 feet above high tide, and will put the inverts of the sewers most distant from the river from 5 to 8 feet below the street level. Under these conditions the proposed sewers will discharge, without difficulty, the greatest storms to be expected.

Deferring Construction of Parts of System.—A large measure of relief can be obtained by building only certain parts of the proposed system at the start, adding thereto additional sewers, as necessary. The success of the system will depend, however, on the satisfactory flushing of the sewers, as proposed herein, and it will be necessary therefore, to add enough of the collectors in each system, and the flush tanks that go therewith, to provide for this feature; otherwise the expense of hand-cleaning at intervals will be considerable.

Cellar Drainage Not Advisable.—I have considered very thoroughly the advantages and disadvantages of providing sewers deep enough to afford cellar drainage in the meadow district, but, viewing it from various angles, have invariably come to the conclusion that the risk and expense are too great for the city at large to assume for the benefit of the few whose requirements would necessitate such accommodations, and that it would be better for those comparatively few individuals who need deep cellars to waterproof them and pump their sewage up to the sewers, as is done so extensively in many of the buildings in lower New York.

Screen and Grit Chambers.—The grit deposit chambers and screens near the outfalls of the main sewers are to be located in chambers under the streets. The screens and deposit chambers are to be kept cleaned by mechanical rakes and buckets kept in slow motion by small duplicate electric motors. The collections at each outfall will have to be removed periodically through a manhole

and disposed of by burning, or other satisfactory means, and the machinery will have to be inspected and oiled daily to keep it in efficient service.

The Flushing System.—The flushing system, which is to be installed also in connection with the existing sewers, will consist of large shallow concrete steel tanks under the streets at the points indicated, supplied with harbor water through pipe lines built in the concrete foundations of the sewers themselves, a flap valve being placed on the end of the supply pipe in each tank. This will permit the tanks to fill on rising tides and prevent the water running out again as the tide falls. At the proper time on the falling tide a sluice gate will be opened automatically and quickly, to let the water run out of the tank into the sewer, the operation of the gate being controlled by a float. A few of the tanks on the old sewers will have to be supplied with city water instead of harbor water, and the cost of this has been included in the estimates of the annual cost of operation.

Submerged Outfalls.—It is proposed, in all cases, to extend the outfall pipe for the dry weather flow of sewage out to the pierhead line and have the pipe submerged so that the discharge will take place at least 25 feet below the surface. This, together with the screening, will prevent the sewage from appearing at the surface, by promoting its thorough dispersion through the tidal flow in the river, and will do away with the formation of the objectionable putrescible deposits in the slips, now so prevalent. Storm water will be allowed to discharge at the bulkhead line, as this will occur but rarely and the sewage will at such time be very dilute.

Foundations.—The estimates of cost are based on reinforced concrete for the larger sewers. All the sewers throughout the meadow district are to be on pile foundations.

Improvement of Canal.—While carrying out the general improvements it will be advisable also to dig up and fill with earth the old outfall sewer on the line of Bloomfield street running south from the Ferry street sewer, as well as the old connections at Henderson street with the Mill Creek sewer, and lay new and smaller sewers to take the sewage, now received by some of these old sewers, to the Ferry street sewer, through properly made connections. The old sewers are simply dead ends which fill up with sewage as the tide rises and empty as it runs out, and are filthy and objectionable to the last degree. Their connections with the Ferry street sewer should be blocked off with masonry.

It would also be advisable to connect the Court street sewer with the Ferry street sewer and fill up and abandon the portion south of the Ferry street sewer. A prominent feature in the improvement of the Ferry street sewer will be the diversion of its dry

weather flow to the improved Newark street outfall at the pierhead line of the Hamburg-American dock.

The above described improvements will clean up the canal and the slip north of the D. L. & W. ferry landing, both of which are in a very objectionable condition.

More Intensive Sewage Treatment Possible.—When looking into the future it appears very probable that the increasing pollution of the harbor waters may in time bring about such conditions that it will be necessary for all the communities bordering on its shores to keep municipal wastes out of the harbor to as great an extent as possible. So long as the nuisances are local only, the problems are easily handled, but before the pollution becomes so great that the whole harbor threatens to become an open cesspool then all the different communities must get together and purify enough of their sewage locally, or jointly, as most convenient and expedient, to prevent such a calamity.

Plan B, as recommended, lends itself well to a still more complete plan of sewage treatment should this ever be necessary. When the time comes settling tanks can be installed under the streets at each outfall, and, if necessary, chemicals can be used in connection therewith to secure more complete subsidence, or sterilzation, or both, or else fine mechanically operated screens might be installed. There would, therefore, be no lost investments in carrying out Plan B if more complete treatment should be insisted upon in the future.

Maintenance.—In order to have satisfactory service from public works of any kind it is essential that they be properly maintained and operated. This will be particularly true of the Hoboken sewerage works. All the sewers will be between high and low water line and the intermittency of the flow of sewage will afford opportunities for the deposit of solids upon the sewer inverts. It, therefore, will be necessary to keep sand, silt and street dirt out of the sewers to as great an extent as practicable, as these matters, after once having settled upon the bottom, are difficult to remove by flushing, particularly when there is an opportunity for salt water to enter the sewers. Looking toward obviating difficulties of this sort it will be appreciated, therefore, that care must be taken to keep the catch basins at street corners properly and systematically cleaned out. By far the greater part of the street floodings in the First and Fourth Wards have been due, in the past, to allowing the catch basins to fill up and their outlets to become choked with mud and debris.

Preparation of Detailed Plans.—All the different plans here discussed have been worked out in considerable detail in order to arrive at reliable estimates of cost, but are presented herein only as summaries, sufficient information being given so that you may understand what is included, in each case, what each plan will ac-

complish and how the different plans compare with each other as to costs of construction and operation. After formal adoption the detailed plans of each sewer to be constructed, together with the screen and grit chambers, submerged outfalls, tide gates, storm water overflows, flush tanks, etc., will have to be made, and specifications will have to be drawn therefor, so that contracts can be let for the construction of such parts as you deem necessary at the present time.

Awaiting your further pleasure in the premises,

Very respectfully,

JAMES H. FUERTES,

Consulting Engineer.

APEENDIX A.

NOTES IN REGARD TO PILE FOUNDATIONS UNDER BUILDINGS IN HOBOKEN.

The following notes give data regarding the lengths of piles used under buildings in various parts of Hoboken:

Fourteenth Street Viaduct.—Mr. W. B. Waldo, the contractor for this viaduct, informs me that piles 110 feet long were driven for some of the pier foundations for this viaduct, the usual length being about 80 feet.

Owens & Traeger Company.—Eleventh street, between Madison and Jefferson streets. Piles 87 feet long were driven for the four-story brick building at the corner of Jefferson street, and piles 30 to 40 feet long for the two-story brick building at the corner of Madison street. This latter building shows some settlement.

J. & W. Stanley.—Piles 40 to 50 feet long were driven for their cooperage shop at the corner of Grand and Tenth streets.

Ferguson Manufacturing Company.—A four-story wooden building on Eighth street, between Monroe and Jefferson streets, occupies the entire block. Piles 55 feet long were driven at the corner of Jackson and Eighth streets, and 80-foot piles driven at the corner of Monroe and Eighth streets. An old inlet extended probably on Monroe street at this point.

Keuffel & Esser Company.—Piles 30 to 40 feet long were driven for the foundations of the five-story brick building at Third street between Grand and Jefferson streets, and also for the new five-story concrete building.

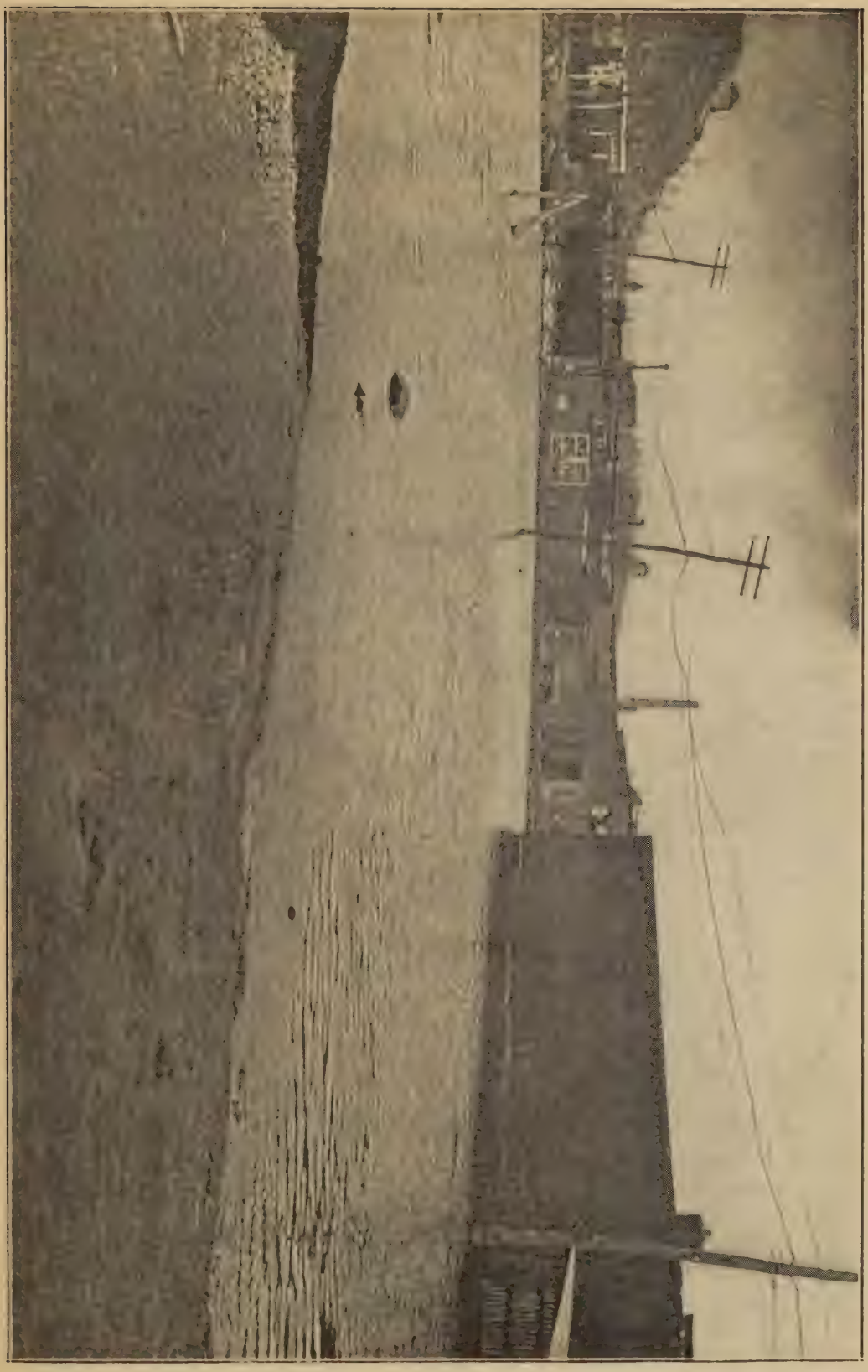
Adams Street near Fifth Street.—On March 28th piles were being driven for a two-story brick building at this location. The piles were about 25 feet long. The last 8 or 10 feet would be considered fairly hard driving.

Elevation at Which Piles Are Cut Off.—The piles under most of the substantial buildings have probably been cut at least below mean high water, but the indications are that this is not always the case. A number of buildings have been observed, the foundation piles of which can be seen where the piles are cut off three or four

feet, and possibly more, above mean high water. An instance of this can be seen in Photograph No. 4, which shows the U. S. Rattan Company's factory at the corner of Madison and Eleventh streets. This building is a four-story wooden building, about 125 feet square.

Another instance is at No. 220 Clinton street. The foundations for a new building were being prepared next to this number, and in excavating for the new building piles could be seen supporting a one-story wooden undertaker's establishment. The tops of the piles were about at the street level, which at that point is 2½ feet above mean high water. These piles are about 12 feet centers.

Another instance is on Adams street near Fifth street, where piles were being driven as mentioned previously, and were being cut off at about the elevation of high water.



No. 3. Taken from a point on Fifteenth Street, between Grand and Adams streets, looking northeast toward Lawson & MacMurray's lumber yard. Portion of Woodman's Mill in the foreground.

APPENDIX B.

DATA REGARDING INCONVENIENCES AND DAMAGES RESULTING FROM FLOODING OF PROPERTIES IN THE LOWLAND DISTRICTS OF HOBOKEN.

During the week ending March 30, 1912, an inspection was made to ascertain the damage and inconveniences resulting to property owners in the lowland districts from lack of sewerage facilities.

The district not provided with sewers at present is principally confined to the Fifth Ward, in the northern portion of the city. Many manufacturing establishments, but few dwellings, are located in this district. The owners and managers were interviewed and the result of these interviews are embodied in the following notes:

Lawson & MacMurray, Lumber Yard.—This firm occupies an entire block between Clinton and Grand streets and Sixteenth and Seventeenth streets. The recent high water caused great inconvenience in loading and unloading cars. The company's railroad siding was under water, and there was a period of five sucecssive days during which cars could not be either loaded or unloaded.

The sewage is discharged into a cesspool near the yard.

Dwellings Nos. 1618-20-22 Park Avenue.—The yards of these dwellings were surrounded with water on the 25th of March, and the basements have more or less water in them during the entire year.

George W. Travers Company, Importers of Toys.—Corner of Adams and Fifteenth streets. There were six inches of water in the basement of this firm's building for about ten days, and the steam plant, which was situated in the basement, was out of service during this period. The basement is used for storage purposes and for repairing toys. Four men were thrown out of employment and a general upset of operations resulted from the water in the basement. Fortunately for the firm, this flooding occurred during a dull period. The manager said that if the high water had occurred during their busy season much damage would have resulted, and other storage facilities would have had to have been provided. As it was, cars could not be loaded and unloaded promptly on account of the basement being flooded with water; the storage space being thus much contracted.

The sewage of this factory is supposed to discharge into the Fifteenth street sewer.

Joel H. Woodman, Veneering Mill.—This plant occupies almost the entire block between Clinton, Grand, Fifteenth and Sixteenth streets. The yard was entirely submerged, the water coming almost up to the boiler floor. General inconvenience resulted, especially in trucking.

The sewage is supposed to discharge into the Fifteenth street sewer.

Dwelling No. 1507 Clinton Street.—Basement flooded. The owner kept boarders and lodgers, who were compelled to leave on account of the water, thus entailing loss and damage.

Wilson Bros., No. 1420 Grand Street, Iron Works.—Building entirely surrounded by water, and the plant had to shut down for three or four days.

The sewage discharges into the Grand street box sewer; but the presumption is that the portion of the sewer in front of these premises has settled with the street and is out of use.

The Ebbecke Furniture Company, Nos. 1416-18 Grand Street.—The yard, cellar and entrance flooded. The piles of lumber in the yard will have to be re-piled. General inconvenience in trucking and the delivery of coal.

The sewage formerly discharged into the Grand street sewer, but recently it had to be disconnected on account of the water and sewage backing up and flooding the cellar.

The sewage now discharges into the ground and finds its way probably to the low places surrounding the building.

The Cabot Manufacturing Company, Planing Mill.—Corner of Adams and Fifteenth streets. Employs 12 to 15 men. During the worst period the yard was under water to a depth of 6 to 12 inches. The buildings were surrounded by water, and the lower floor of the shop flooded. It was necessary to shut down the mill for about ten days, throwing 12 men out of employment for that time. A great deal of damage was done to the stock, the finished doors and sashes stored in the cellar had to be gone over, and the discoloration caused by the water removed. It was also necessary to renew the glue in the joints of the doors and sash. This resulted in considerable damage to the buisness.

The sewage discharges into a cesspool near the building, making a very serious nuisance.

Dwellings Nos. 1408-10 Adams Street.—These dwellings are entirely surrounded by water and 2 feet of water in the cellar. Sewage discharges into cesspools or out on the meadows.

No. 4. From the corner of Twelfth and Adams streets, looking northeast.

A. Schwartzwalder & Sons, Cooperage.—This firm occupies the entire area between Fourteenth and Fifteenth streets and Jefferson street and the railroad. The lumber yard was flooded, causing great inconvenience in getting to the lumber piles and the storage sheds. The boiler room was flooded, necessitating using pumps to keep the water out to prevent shutting down the mill. Even with the strenuous efforts made to keep running, the mill was compelled to shut down for three or four hours at one period.

The sewage of the factory discharges into cesspools.

Dwellings Nos. 1603-5 Madison Street.—Entirely surrounded by water for many days. The furniture on the first floor of 1605 had to be removed. The cellar of 1603 flooded.

The sewage discharges on to the meadows.

J. & W. Stanley, Cooperage.—Corner of Grand and Thirteenth streets. Employs 5 or 6 men. Sewage discharges into the box drain on Grand street, but, since it is believed that this sewer is out of use between Fourteenth and Fifteenth streets, the sewage probably finds its way to the low places surrounding the building. Very bad odors are frequently observed.

Barr, Thaw, Fraser Company, Ornamental Stone.—Corner of Thirteenth and Adams streets. The water got high enough to cover 6 or 8 inches deep belts, pulleys, etc. It came within 3 or 4 inches of the boiler fire box.

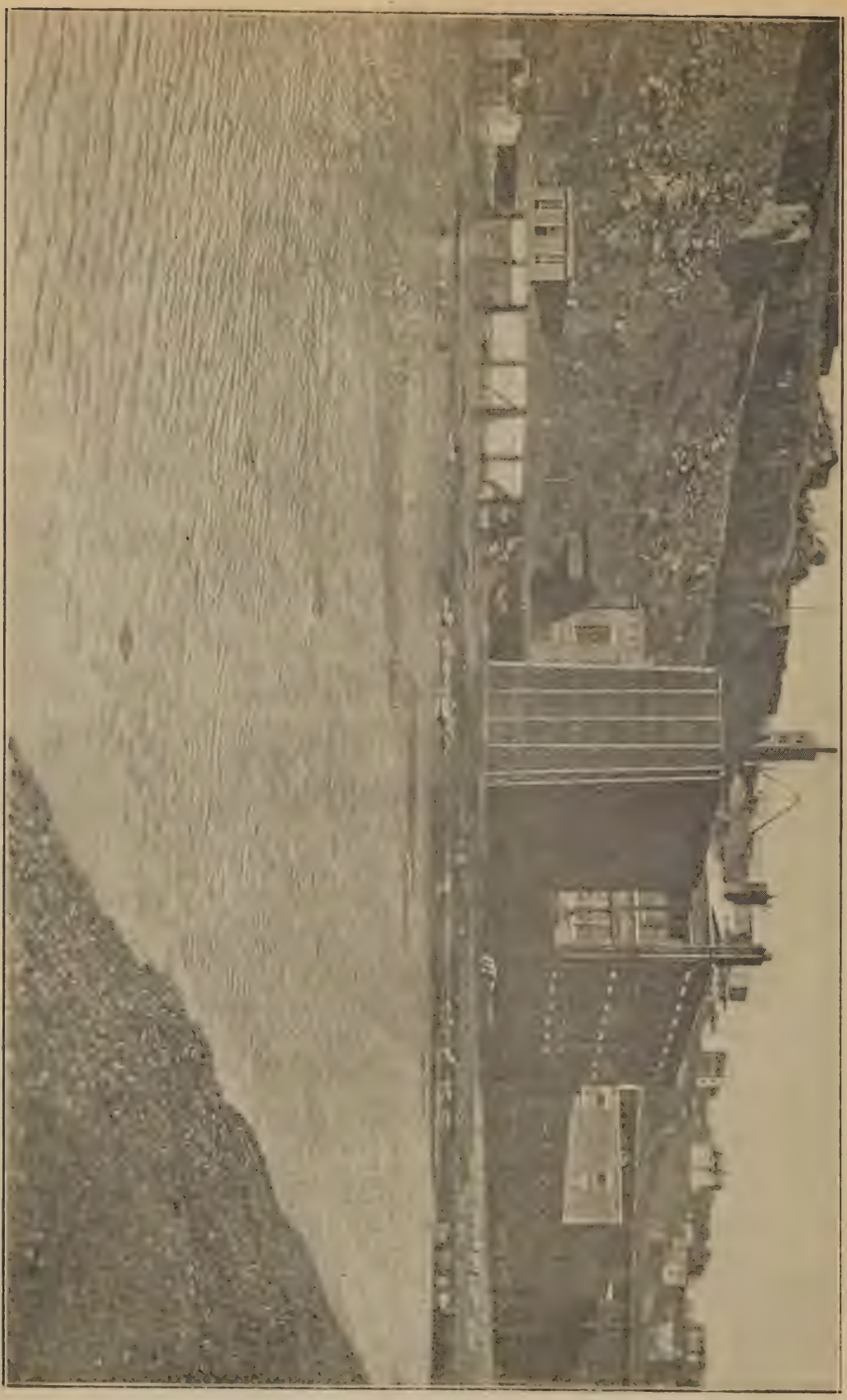
The sewage discharges to the meadows on the west side of Adams street, which are under water the entire year.

The Hudson Consumers Ice Company.—Monroe street between Twelfth and Thirteenth streets. This factory is surrounded by water all the year, but in the summer time it is not quite so deep as it is at present.

The sewage discharges directly on to the meadows and into the pools of water surrounding the building. The manager states that in summer the sanitary conditions are extremely bad; obnoxious odors are constantly observed, and the flies swarm about the building and meadows during the summer time; no one who has not seen the conditions in the summer time has any conception of the offensive odors and the nuisance caused by the flies. Many residents in this section, and, in fact, all over the meadow district, complain bitterly of the myriads of flies which are found there during the warm months.

Joseph N. Courtade, Piano Cases.—Corner of Twelfth and Grand streets. Water in basement and boiler room. Compelled to shut down one day when the water was highest. The water covers the meadows of this neighborhood during the whole year.

The sewage discharges directly into the ponds at the rear of the factory.



No. 5. From a point on Madison street half-way between Eleventh and Twelfth streets, looking north toward Hudson Consumers Ice Company. This view does not show clearly the water surrounding the Ice Cmpany's plant; but water from two to three feet deep extends along the whole length of the building and out to Madison street.

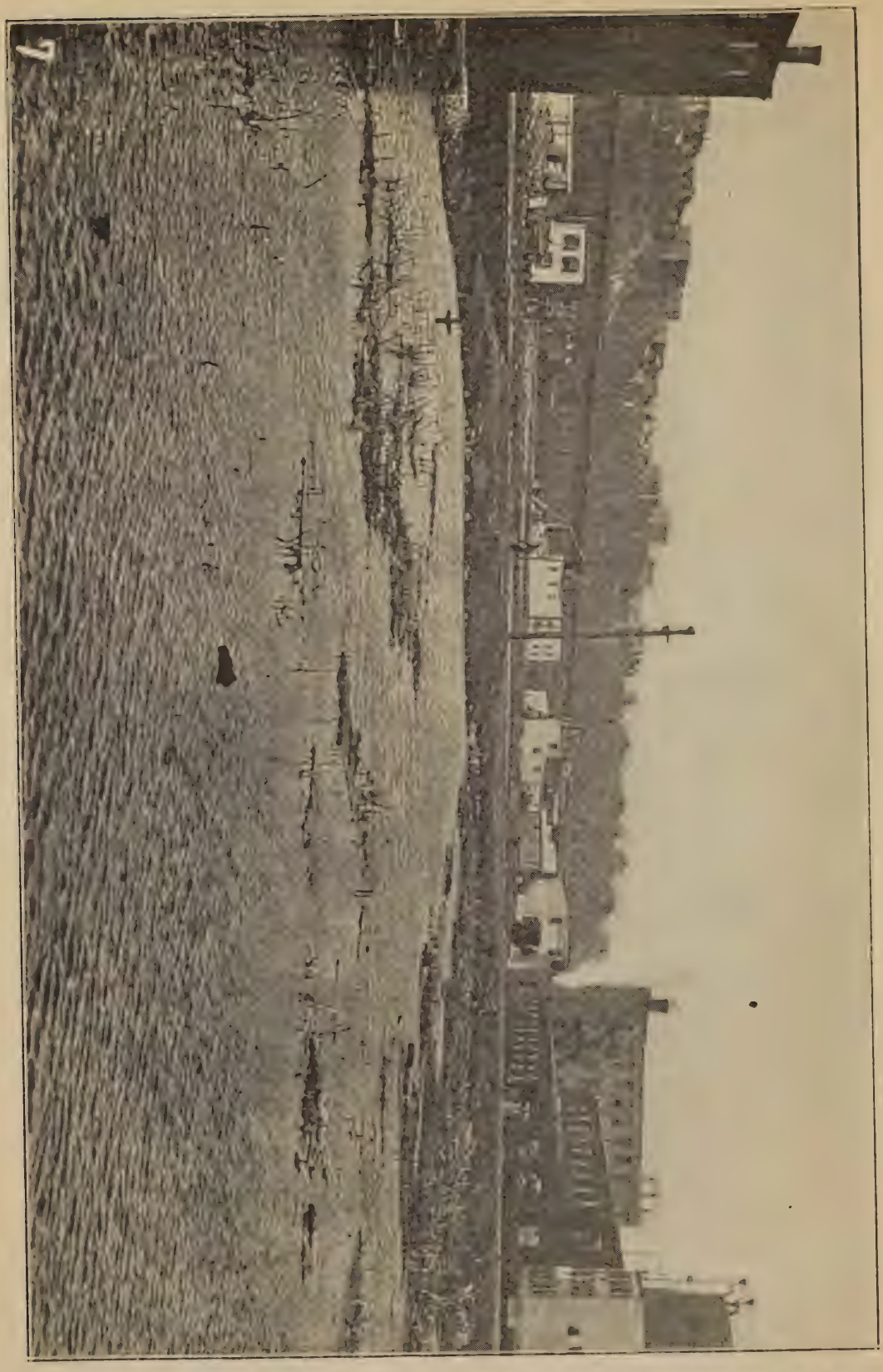
Owens-Trager Company, Paper Boxes, etc.—Eleventh street between Jefferson and Madison streets. Employees, 240. Water in the boiler room floor, necessitating constant pumping to keep it out and the factory running. One of the owners states that when the building was built the boiler room floor was placed 10 inches above high water. Since then the meadows in this neighborhood have been used as dumps, and the water level on this account been gradually rising. About two years ago it was necessary to raise the boiler floor 10 inches, but since then the water level has continued to rise, owing to the gradual filling in of the meadows. Thus it is seen that although the boiler room floor is 20 inches higher than when the building was built, a hard rainfall now floods the boiler room floor.

The sewage is discharged into a cesspool located in the rear of the Fabric Rubberizing Company's plant, on the public dump. Into this cesspool is also discharged the sewage of part of the Hoboken Ribbon Company's plant, located on the opposite corner of Owens-Traeger Company.

In connection with this matter the following letters to Mayor Cooke from Messrs. Owens & Traeger and White & Reid were published in the Hudson Observer, March 27th, 1912. (Mayor Cooke informed me that he had received many other letters of a similar nature).

From Owens & Traeger:

> "We write to ask if the matter of draining the meadows, which was so earnestly taken up by you last fall, has for any reason been side-tracked or held up. At the present time the conditions are in the most serious form that they have ever been in this section of the city.
>
> "We have our boiler room flooded and the water is within eight inches of our first floor. Eleventh street is sinking in many places, and it is only a matter of a short time when we will have to look for quarters outside of Hoboken. We are not only speaking for ourselves, but for other manufacturing concerns in the meadows.
>
> "It is getting to the point where we cannot get our help down here, to say nothing of the delivery wagons. Furthermore, the first story in all of our buildings is becoming practically useless. One of two things must be done. Either stop filling in all sections of the meadows and give the water to go, or else drain the meadows. The future manufacturing interest of this city is to be governed entirely by future conditions, and one of the above-mentioned reliefs must be enforced.



No. 6. From north line of Park avenue and Adams street, looking north; showing pond directly in front of Park, into which the sewage from the Hoboken Ribbon Company's and the Automatic Hook and Eye Company's factories discharges. The cross denotes the place of discharge.

If the city of Hoboken wishes to drive all manufacturers away, it can be easily acocmplished by leaving the conditions run along, getting worse, without any apparent effort to benefit the situation."

From White & Reid:

"We are pleased to have yours of the 21st instant, and glad to know that you are taking the interest on the sewerage question that you show. In the meantime, we believe that if the drains between the various ponds of this locality and Fifteenth street were opened, so that there could be a flow of water to the river, that it would greatly help the situation, and not put the city to any large expense.

"When we first took this property there was a steady flow of water to the river, but the continued filling in of the meadows and the accumulation of dirt in the drains has apparently cut this outlet off entirely. Since we wrote you we have heard of several other factories that were shut down on account of the high water.

"This high water is not due to rainfalls, as the records show the rainfall has been very light for past two months, but is due to the accumulation and the stoppage of the proper outlets. We believe a personal investigation will show you that all these ponds can be drained into the river at a very small expense to the city and relieve what is now a critical condition."

Hoboken Ribbon Company.—Corner of Eleventh and Jefferson streets. Employs from 200 to 300 when running full time. The basement of this large factory is flooded almost the entire year, but if it were dry the company would use it for many purposes.

Part of the sewage of this building discharges into the same cesspool that the sewage of the Owens-Traeger Company discharges into. The remainder discharges into the pond north of the city park on Adams street. The water level has risen during recent years, undoubtedly owing to the filling in of the meadows. In warm weather bad odors and the myriads of flies make the conditions almost unbearable. Much nuisance and damage is caused in this factory by the flies.

The Automatic Hook & Eye Company.—Corner of Eleventh and Adams streets. 25 to 40 employees. The sewage discharges into the pond east of the building, and directly in front of the city park. Uses same discharge box that the Ribbon Company uses.

No. 7. Showing the southwest corner of the United States Rattan Company's factory at corner of Madison and Eleventh streets. The white cross designates the location of the factory's sewage discharge pipe. The sewage discharges into a cess-pool about 15 feet from the building, but it is frequently flooded (as it is now) and the sewage flows under and around the building, causing offensive odors and bad sanitary conditions.

No. 8. Taken from the west side of the park near the north line, on Jefferson street looking west; showing pond and public dumps in view of the park.

The Fabric Rubberizing Company.—Corner of Eleventh and Jefferson streets. Twenty employees. Basement flooded with water, and pumping has to be resorted to frequently in order to keep the water down so that the factory can run.

The sewage discharges into a cesspool in the yard.

United States Rattan Company.—Corner of Eleventh and Madison streets. 25 to 30 employes. This large factory is surrounded by water all the year. The sewage discharges into a barrel cesspool located in the pond directly west of the building. During the last two weeks of March the barrel has been flooded, and the sewage floats under and around the building, causing very bad sanitary conditions. See Photograph No. 4.

Dwellings on the West Side of Madison Street, Between Tenth and Eleventh Streets.—These discharge their sewage on the flooded meadows at their rear.

The Ferguson Manufacturing Company, Novelties.—320 employees. For the past two weeks the yard and building have been flooded with water, although no special trouble has been caused except for some inconvenience in loading and unloading cars. The sewage of this factory and the surface drainage about it discharge into the sewer at the corner of Monroe and Eighth streets.

Riches-Piver & Company, Chemicals.—Jefferson street. Employs four or five men.

The sewage is discharged on the meadows at the rear of the building. The company also discharges about 2,000 gallons of water every 10 hours on the meadows.

John Deltour, Bamboo Works.—Jefferson street. 25 employes. The sewage is discharged into a cesspool located at the rear of the building.

Other factories and buildings in this same block discharge their sewage into cesspools at the rear.

Reade Manufacturing Company.—Nos. 1017-21 Grand street. The sewage of this factory is discharged through private property into the Clinton street sewer. The factory has a fairly deep basement (about 5 feet below the grade of Grand and Eleventh streets) and the company is not troubled in the least with the water or sewage.

The conditions at this factory and those surrounding it having fair sewerage conditions are in marked contrast with those factories only one or two blocks away, which have no sewerage or drainage facilities.

No. 9. Taken from a point about 10 feet above the railroad tracks on the south line of Sixth street looking northeast toward Seventh and Jackson streets.

No. 10. Taken from the railroad tracks on the north line of Fourth street, looking south toward Third and Marshall streets.

Keuffel & Esser Company.—This company has two large factories on Third street, one between Adams and Jefferson streets, which is a fiv-story concrete building, and the other between Adams and Grand streets, which is a five-story brick building. The basement of the brick building is not used because water rises in it at various times, although the company was careful when the building was constructed to place it above high water mark. Mr. Keuffel states that if it were not for the frequent flooding of the basement they could use it to good advantage. When the concrete building was erected the company decided that it would be useless to provide a basement on account of the bad drainage.

Jackson Street, North of Fifth Street.—Dwellings on east side have cesspools in their rear. No dwellings on the west side.

APPENDIX C.

STREET FLOODINGS AND THEIR CAUSES.

As a result of the frequent complaints of the flooding of the street intersections in certain localities, and the general opinion that the overflowing of the sewers was the cause, inquiries and investigations were made to determine, if possible, the source of the trouble at the places most frequently flooded.

Clinton and Second Streets.—Although this corner, the elevation of which is 1.58, is not the lowest in the city, it is flooded frequently; a resident says at least 100 times a year, and very frequently during the summer. It is flooded many times when no rain has fallen for days, thus proving that in these cases at least, the sewer becomes full and overflows. In fact, at these times residents have observed sewage flowing out of the catch basins. In summer these overflows cause obnoxious odors.

On March 29th, after a heavy rain, which ended about two hours after high tide, the streets here were flooded above the curbs and almost to the building lines. Four hours after high tide the water had receded and the streets were dry, no cleaning of the catch basins having been done.

On May 9th, about one-half hour before high tide, and twenty minutes after a **very heavy** downpour of ten minutes' duration, the sewage stood at elevation -|- 0.35 in the sewers. At the same time the surface water was surrounding the catch basin 2 or 3 inches higher than the sewage elevation. The surface water gradually receded through the catch basins.

These two observations seem to prove that while the catch basins were not altogether clogged up, they were not absolutely free, and could not discharge the surface water into the sewers as fast as it reached them; also, that the sewers could not discharge the surface water as rapidly as it reached them. In these two instances a combination of both circumstances probably resulted in the flooding of the streets.

Clinton and Third Streets.—On March 29th the same conditions prevailed at this corner, which is at elevation 1.97, as noted above at Clinton and Second streets, the flood receding gradually, as at that point.

Third and Willow Streets.—The streets here, at elevation 2.60, were not flooded after the heavy rain of March 29th, but water was seen to rise up to the level of the inlet of one of the catch basins on the corner. The inlet is about elevation -|- 2.0. Either the sewage rose to that elevation or the catch basin was not free enough to discharge the surface water as fast as it received it.

Third and Adams Streets.—Occasionally the sewage backs up and flows out of the catch basins, flooding the street intersections, which are at elevation 2.47. Sewage has been seen to float on the surface at these times.

Third and Jefferson Streets.—After heavy rains Third street, elevation 2.74, is flooded between Jefferson and Madison. On both sides of Jefferson, Third street is about one foot lower than the intersection, but the block to the east is drained by a basin located at the low point. The block toward Madison street is flooded because the gutters are lower than the catch basins at the corners.

Park and Newark Streets.—After the heavy rain of March 29th the northeast corner, elevation 1.8, was flooded 6 inches deep, and remained so until the city authorities cleaned out the catch basin on that corner. This flooding was entirely due to the clogging up of the catch basin, because there was no water standing at the other corners where catch basins are also located. The streets here are frequently flooded, the flood extending on Newark street one block either way from Park street. Undoubtedly this is sometimes caused by the sewers overflowing through the catch basins, because sewage can be seen floating on the surface.

Park and Second Streets.—A resident states that formerly water would flow out of the catch basins after heavy rains and flood the streets, at elevation 3.3, about 1 foot deep. About six months ago the basins were cleaned and no flooding has since occurred. When the overflows occurred strong odors of sewer gas would be observed. One of the catch basins was inspected and found to be filled with mud, papers, cardboard, street refuse, etc., to above the outlet pipe.

Clinton and Tenth Streets.—The superintendent of the Autographic Register Company, located on this corner, says this intersection, at elevation 4.8, is flooded frequently to a depth of 2 to 3 feet, and has occurred five or six times during the past six months. The basement of the factory is about 4½ feet below the level of the street intersection, and is usually dry, but when the streets are flooded care has to be taken to prevent water flooding the basement. The windows are boarded up permanently to nearly their full height to prevent flooding.

The Superintendent is under the impression that the sewers overflow, but this corner is at such a comparatively high elevation it is improbable that such is the case, but that the real trouble is due to the catch basin being clogged up.

On April 18th, during a fairly hard rain, the following street intersections were observed to be flooded. The reason in all cases was the clogging up of one or more catch basins.

Third and Willow Streets.—Elevation 2.6, water standing almost to curb level about one basin; the other three basins were taking the water freely.

Third and Hudson Streets.—Elevation 18.7, one basin was flooded to top of curb, and surface water flowing across crown of street into the opposite one, which was taking it freely.

Newark and Grand Streets.—Elevation 1.22; the surface water surrounded the two basins here, and extended from curb to curb at the street intersection and along the west curb of Grand street to the corner of Grand and First streets; all three catch basins were stopped up.

Jackson and First Streets.—Elevation 2.64; the street was flooded around one catch basin, but the other three basins were clear.

Jackson and Fourth Streets.—Elevation 2.43; the street was flooded around the two southern catch basins, but the two northern ones were clear.

Monroe and Sixth Streets.—Elevation 3.05; the southwest corner was flooded, while the other three catch basins were clear.

Madison and Seventh Streets.—Elevation 3.6; the southwest corner was flooded, while the other corners were clear.

Similar facts have been noted many times at widely separated parts of the city. Many catch basins have been inspected and found filled up to above the outlet pipe with mud, papers, and all kinds of street refuse. No systematic attempt is made to keep the basins clean. The only time they are cleaned is when complaint is made.

Conclusions.—The conclusions to be drawn from the above data are:

First:—The great majority of the street floodings are due to the clogging of the catch basins.

Second:—At times of heavy downpour and long continued rain, the catch basins, while not altogether clogged up, may still not be free enough to discharge the water into the sewers as fast as it comes to them.

Third:—At times of heavy rain storms occurring between two hours before and two hours after high tide, the discharging capacity of some of the sewers is not sufficient to care for the sudden increased flow reaching them.

Fourth:—When the sewers overflow during dry weather, it is because there is a large increase in the volume of sewage flow, or because (and with much greater probability) the tide gates have not been opened or shut at the proper time. If the maximum rate of flow should occur at or near high tide, this might also cause overflowing.

Fifth:—If every street was at least 2½ feet above high tide it is hardly probable that street flooding would occur if catch basins were kept clean and free to discharge the surface water coming to them.

Sixth:—The tide gate at the Third street outfall, being an automatic gate instead of one operated by hand, **prevents** more frequent flooding, because as the sewage rises to elevation, plus 2 or 2½, the gate tends to open and permit a discharge to take place.

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SEWERAGE AND DRAINAGE OF HOBOKEN N. J.

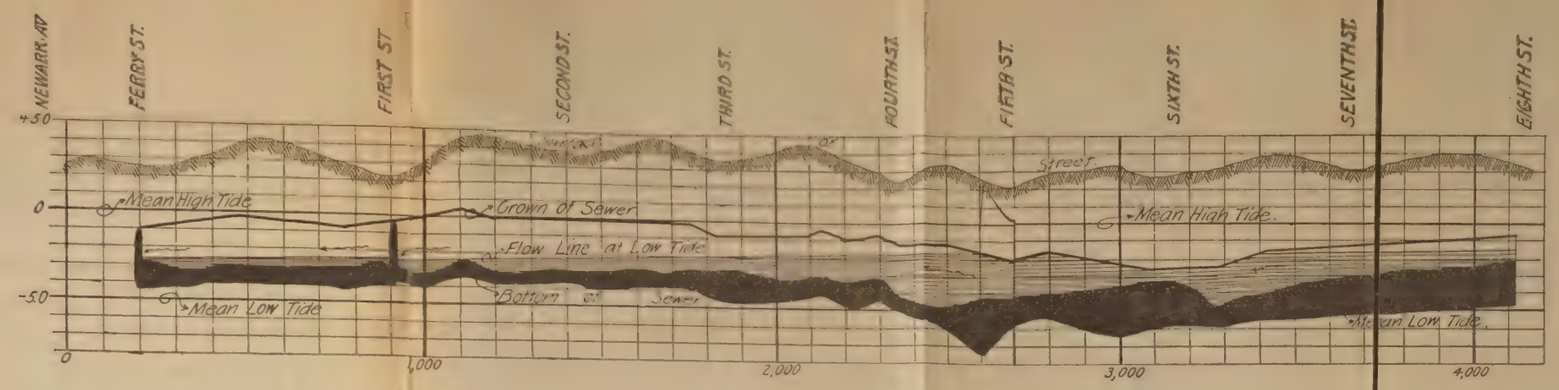
PROFILES OF EXISTING SEWERS.

These Profiles show the actual condition of the Principal Sewers in Hoboken on May 1st. 1912.

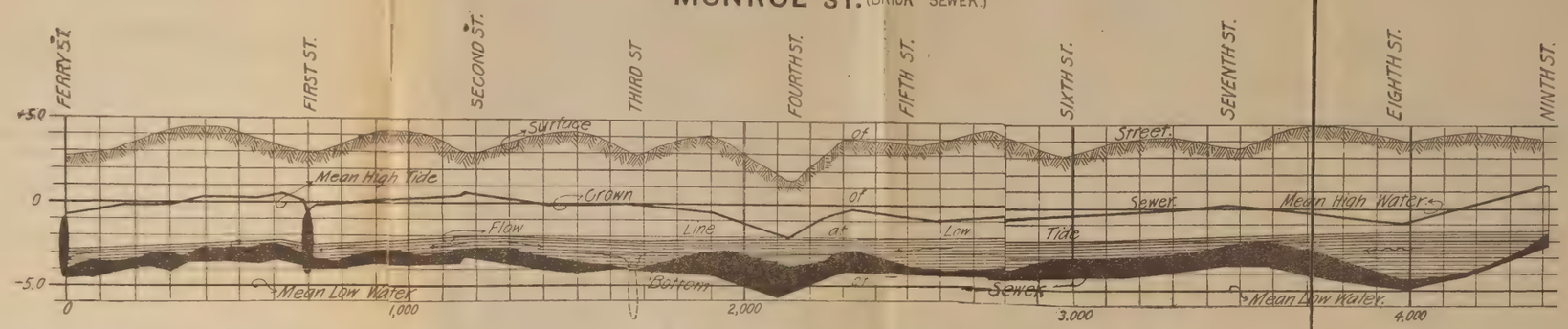
The area cross-lined shows the portion of the Sewers capacity constantly filled with Sewage, the Surface of the Sewage falling no lower than the Line marked "Flow Line at Low Tide".

Deposits of mud and Sludge shown in black

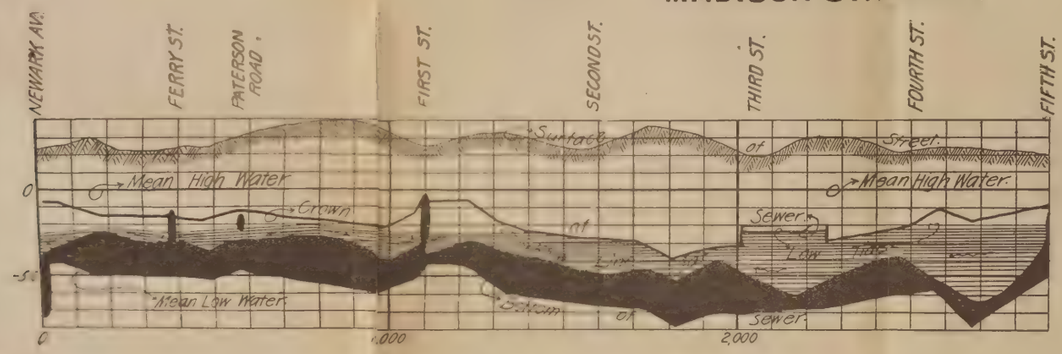
Horizontal Scale: 1"=200'.
Vertical Scale: 1"=4'



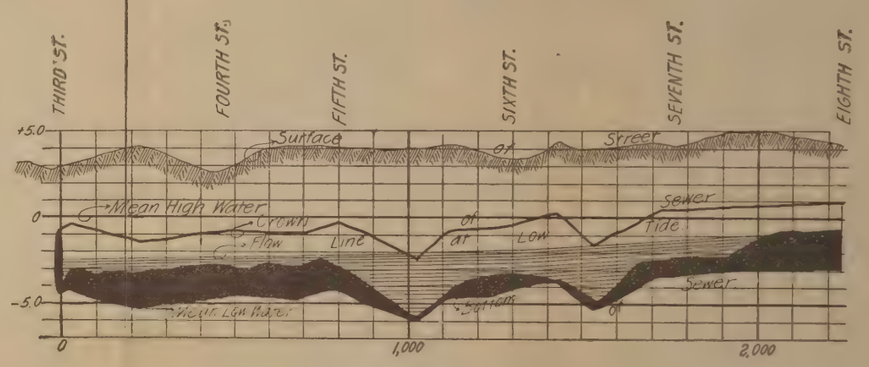
MONROE ST. (BRICK SEWER.)



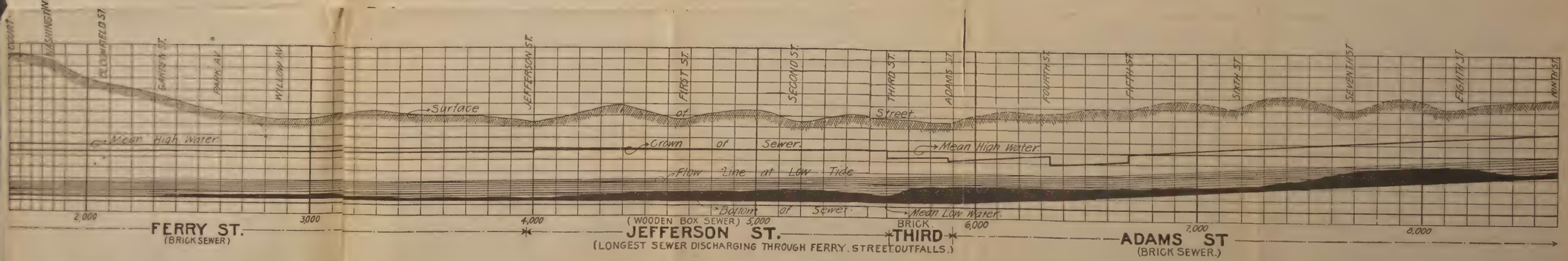
MADISON ST. (BRICK SEWER)



JACKSON ST. (BRICK SEWER.)
(NEWARK TO FIFTH STREETS.)



JEFFERSON ST. (BRICK SEWER.)
(THIRD TO EIGHTH ST'S.)



FERRY ST. (BRICK SEWER)

JEFFERSON ST. (WOODEN BOX SEWER) 5,000 BRICK.

THIRD 6,000

ADAMS ST (BRICK SEWER.) 7,000 8,000

(LONGEST SEWER DISCHARGING THROUGH FERRY STREET OUTFALLS.)

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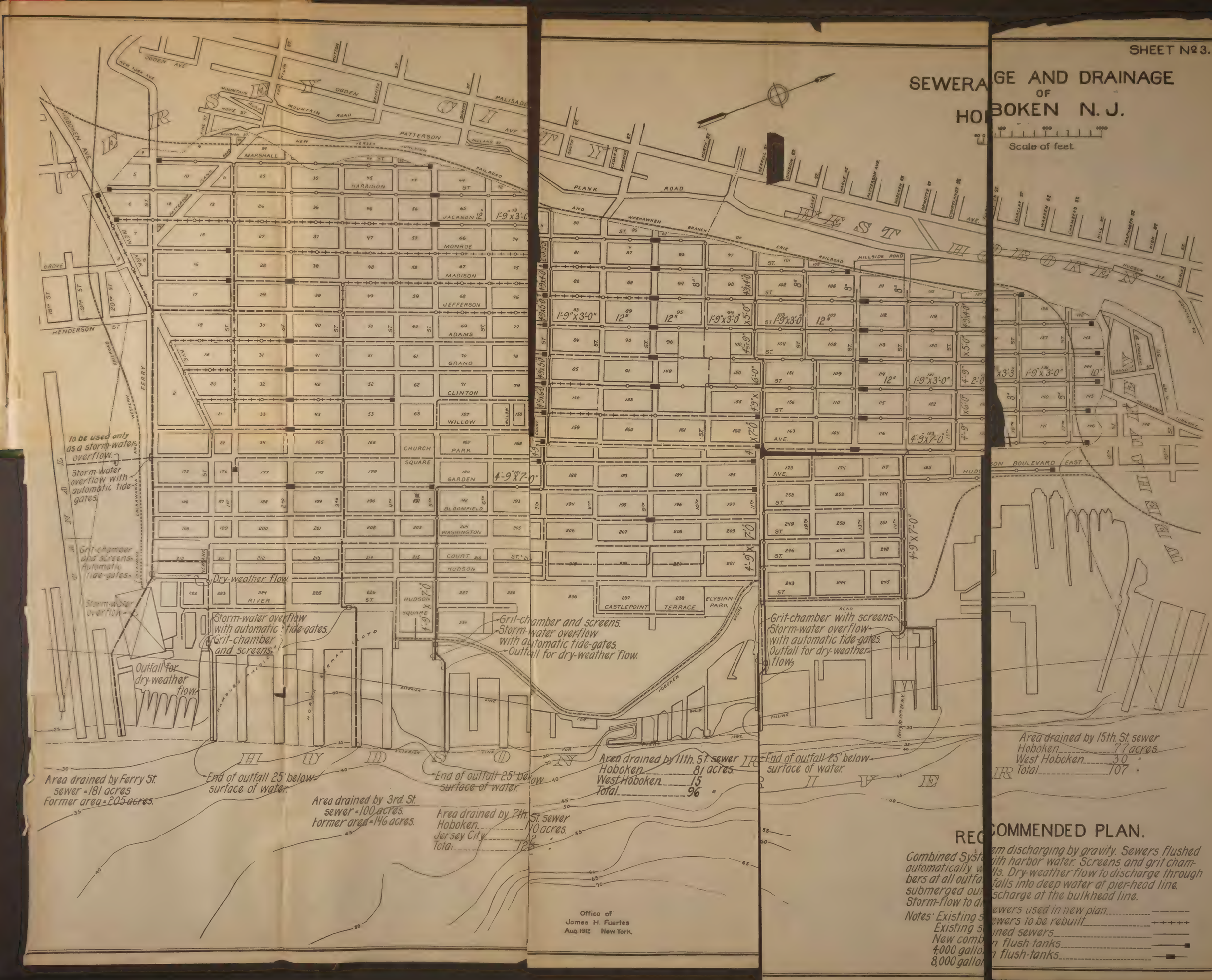
SHEET Nº 3.

SEWERAGE AND DRAINAGE OF HOBOKEN N. J.

Scale of feet



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RECOMMENDED PLAN.

Combined System discharging by gravity. Sewers flushed automatically with harbor water. Screens and grit chambers at all outfalls. Dry-weather flow to discharge through submerged outfalls into deep water at pier-head line. Storm-flow to discharge at the bulkhead line.

Notes: Existing sewers used in new plan _____
Existing sewers to be rebuilt _____
New combined sewers _____
4,000 gallon flush-tanks _____
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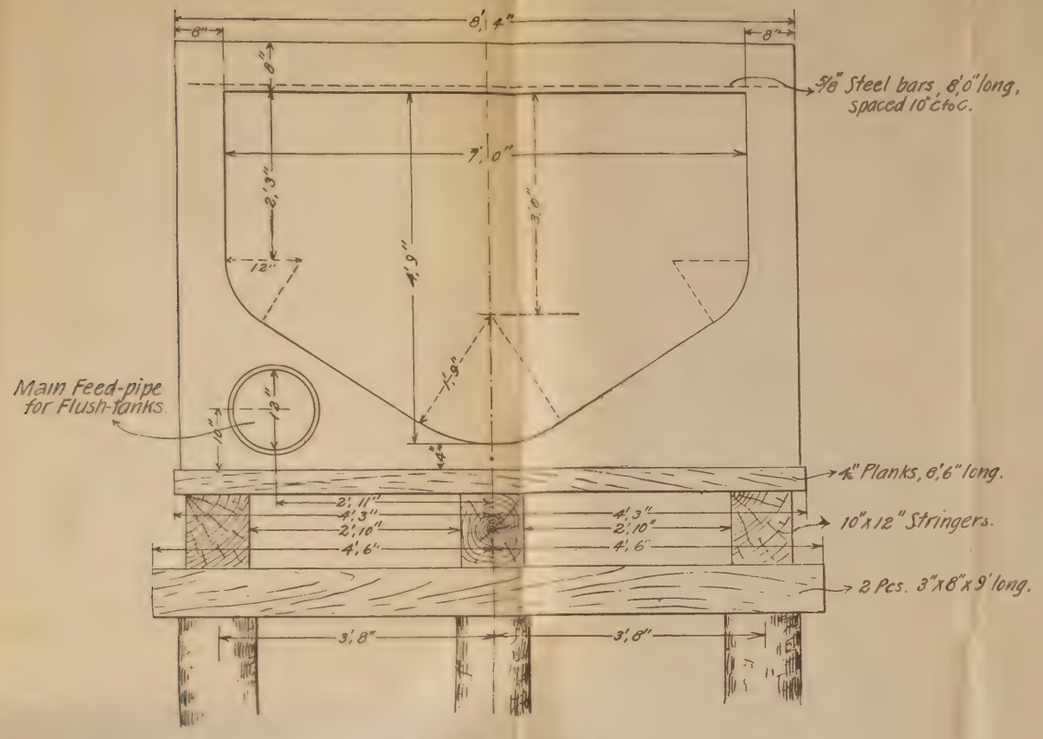
SEWERAGE AND DRAINAGE OF HOBOKEN N.J.

TYPICAL SEWER SECTIONS

Scale: 1"=1.

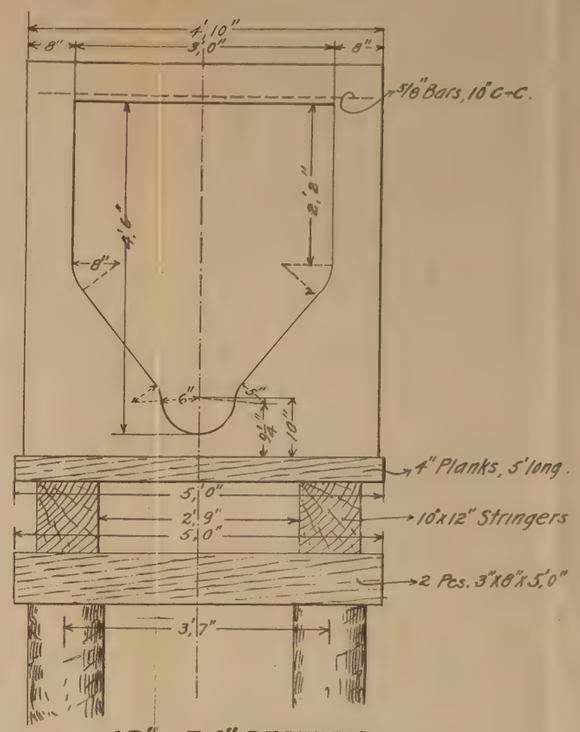
The estimates of Cost of the different Plans have been based on the types of Construction here shown.

Pile bents to be not over 6'0" apart.



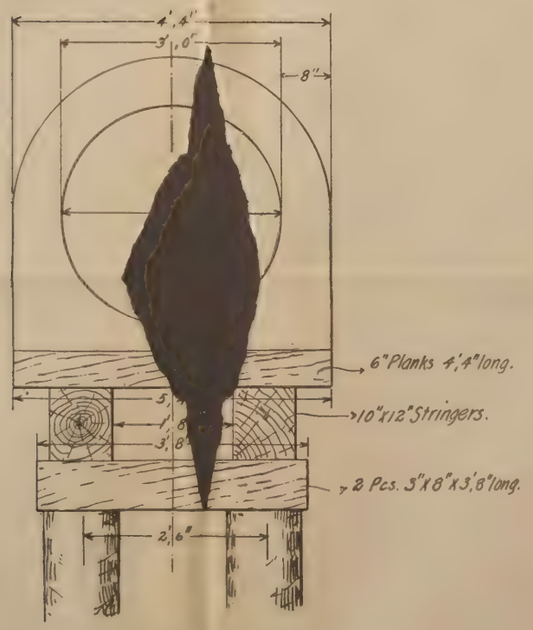
4'9"x 7'0" SECTION.

(PLAN B.)



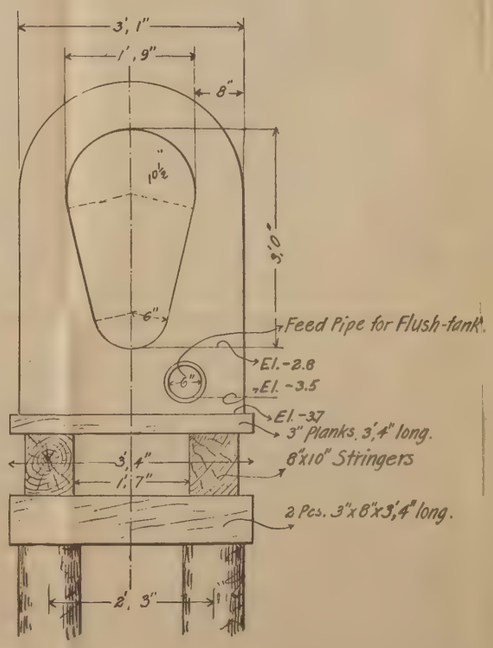
42"x 54" SECTION.

(PLAN D.)



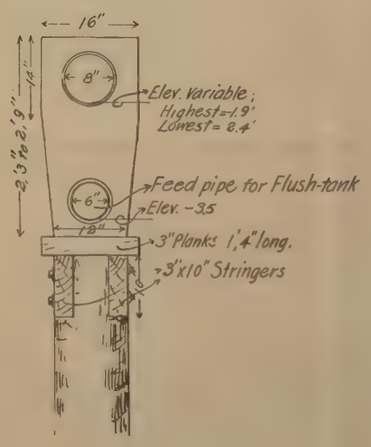
36" TRUNK SEWER.

(PLAN F.)



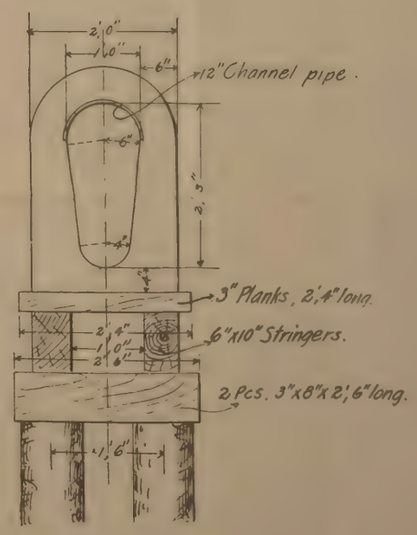
21"x 36" COLLECTOR

(PLAN B.).



8" LATERAL

(PLAN B.)



12"x 27" COLLECTOR.

(PLAN D.)

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